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Fur Seal Investigations, Pribilof Islands, Alaska, 1965

by Alton Y. Roppel, Ancel M. Johnson,
Raymond E. Anas, and Douglas G. Chapman

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ALTON Y. ROPPEL, ANCEL M. JOHNSON
RAYMOND E. ANAS, and DOUGLAS G. CHAPMAN

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ABSTRACT

The age classification of 40,367 male fur seals (Callorhinus ursinus) killed on the Pribilof Islands in 1965 was: age 2, 4 percent; age 3, 56 percent; age 4, 36 percent; and age 5, 4 percent. The ages of 901 male seals were not determined. The peak of the kill occurred 27-31 July. Predicted kills of 3- and 4-year-old males on St. Paul Island were 33,000 and 16,000; actual kills to 9 August were 19,009 and 12,046. All 2-year-old males available 22-26 July on St. Paul Island were killed to determine if abundance on land at age 2 is related to return of the year class at age 3. To test the commercial value of their skins, 854 males larger and older in appearance than those normally taken were killed. Harem and idle bulls counted on the Pribilof Islands were 10,470 and 6,729. Of 10,432 females killed, St. Paul Island contributed 7,530, and St. George Island, 2,902. Selective killing for young females on St. Paul Island 23-27 August produced 88 percent in ages 2-5; nonselective killing on St. George Island 16-27 August produced 64 percent in ages 2-5. Sixty-five 3-year-old females examined were nulliparous; 1 of 51 4-year-old females was primiparous and recently post partum. Recoveries of marked seals included 4,947 with tags or checkmarks applied in the year of birth, 238 selected and tagged as yearlings in previous years, and 36 seals tagged by the U.S.S.R. Ten thousand pups were single-tagged and checkmarked, and 20,087 were checkmarked only; 922 seals were double-tagged as yearlings. Pup mortality on land was 46,308. On the basis of tag recoveries from males and counts of dead pups, about 560,000 pups were born on the Pribilof Islands in 1961 and 500,000 in 1962. On the basis of tag recoveries from females, 344,107 pups were born in 1960, 527, 482 in 1961, and 337,012 in 1962. Marked-to-unmarked ratios yielded an estimate of 347,000 pups born on the Pribilof Islands in 1965. From tags recovered in 1965 from seals tagged as yearlings in previous years, we estimated that there were 78,000 yearling males in 1961 and 85,000 in 1962. The average weight of untagged and unmarked seal pups exceeded that of tagged and marked seal pups by 1.14 kg. (males) and 1.04 kg. (females). The predicted kill of male seals on St. Paul Island in 1966 includes 3,000 of ages 2 and 5, 26,000 of age 3, and 14,000 of age 4. Female seals will not be purposely killed in 1966.

INTRODUCTION

Two recent advances in research are important for management of fur seals (Callorhinus ursinus) on the Pribilof Islands. First, we are making better estimates of the number of pups born, the number of females required to bear these pups, and the number of females needed each year to replace those that die. Second, we are studying the value of finished sealskins by age and sex.

Estimates of the number of pups born based on the tag-and-recovery method have long been known to be inflated, mainly as a result of tag-induced mortality and loss of tags. Additional pups are now marked each year by shearing a patch of fur, and estimates of the number born are obtained by sampling for a marked-to-unmarked ratio 1 to 3 weeks later. The estimates from shearing were similar to complete counts of pups on several small rookeries.

By applying to the pup estimates the pregnancy rates and mortality of seals obtained by pelagic sampling, we can estimate the number

Note.--Alton Y. Roppel and Ancel M. Johnson, Wildlife Biologists (Research), and Raymond E. Anas, Fishery Biologist (Research), Bureau of Commercial Fisheries Marine Mammal Biological Laboratory, U.S. Fish and Wildlife Service, Seattle, Wash. 98115; and Douglas G. Chapman, Laboratory of Statistical Research, University of Washington, Seattle, Wash. 98105.

of females necessary to produce a given number of pups and the recruitment needed to maintain a given level of the female population.

Experimental skins now being processed will make it possible to compare the relative value of sealskins from males and females of various ages. This information, together with information on the mortality of seals of each age, will be used to regulate the kill so as to obtain the maximum monetary value from a year class of seals.

This report summarizes the research data collected on the Pribilof Islands in 1965 and discusses (1) the population dynamics of the seal herd, (2) the reproduction of males and females, and (3) other studies. Forecasts of the kill of male seals in 1966 are given in appendix A.

POPULATION

This section presents information on techniques used to regulate the kills of male and female seals in 1965, and briefly discusses research methods and results having immediate application to studies of fur seal population dynamics.

Males

Male seals of all ages, particularly those age 3 and older, return to the Pribilof Islands each summer. Those from age 1 to about age 9 haul out on areas adjacent to the rookeries. Termed hauling grounds,[1] these areas yield the bulk of the commercial harvest of males, of which more than 90 percent is made up of 3- and 4-year-olds. Several thousand males age 9 and older haul out on traditional rookery or breeding grounds where they acquire harems of 1 to 100 females (average 25) each. Information on the number of males of each age killed commercially for their skins, and knowledge of the number of harem and idle (reserve) bulls that return to the Pribilof Islands each summer is needed as a basis for managing the herd.

Commercial kill.--In 1965, male seals were killed daily from 7 July to 9 August on St. Paul Island, and on Mondays, Wednesdays, and Fridays from 7 July to 6 August on St. George Island.

All available subadult males 42.0 inches (106.7 cm.) long or longer (tip of nose to tip of tail), but without manes, were taken on the Pribilof Islands in 1965. A minimum limit of body length allows most 2-year-old males to escape the kill; a maximum limit (indicated by the presence of a mane) allows the recruitment of males age 6 and older into the breeding reserve. Because the mane (long, silver-colored guard hairs on back of the neck and on the shoulders) is not evident until about age 6, use of this secondary sex characteristic permits the killing of nearly all of the available 3-, 4-, and 5-year-old males.

As in previous years, the age classification of males killed in 1965 was based on samples of canine teeth. This information is presented in appendix tables 6, 7, 8, and 9. The trend in the kill of 3- and 4-year-old males is illustrated in figure 1 for St. Paul Island and in figure 2 for St. George Island. Table 1 shows the kill of male seals on the Pribilof Islands for the 1947-63 year classes, table 2 illustrates the dates at which certain kill levels were reached in the years 1954-65, and table 3 shows the cumulative numbers of males killed each year on St. Paul Island 1955-65.

The minimum limit of body length was removed on St. Paul Island 22-26 July 1965 to allow a complete kill of 2-year-old males in the drives. This was the second year of a study designed to determine if the abundance of 2-year-old males on land in late July is related to the kill of 3-year-olds the following year. Age and body length were determined for 20 percent of all males killed during the 5-day period.

In addition to the regular kill and the special kill of 2-year-olds, 854 males larger and older in appearance than those normally taken were killed to test the commercial value of their skins. The ages of 361 males taken 12-21 July ranged from 4 through 8 (80 percent were in ages 5 and 6). Age was not determined for 493 oversize males taken 22 July to 9 August.

Beginning 27 July 1965, collection of canine teeth, recovery of tags, and recording of checkmarks from male seals killed on St. Paul Island was transferred from the killing fields to the byproducts building. Built in 1918 and used until 1961 as a facility for rendering seal carcasses into meal and oil, the byproducts building was converted in 1964 to a plant for grinding and freezing carcasses of seals that have been eviscerated and beheaded. The ground product is used as mink food.

In 1965, carcass-handling facilities were improved by the installation of a constantly moving overhead cable driven at the rate of 6 feet per minute by two electric motors. Attached to the cable at 12-inch intervals were 360 long-shanked hooks. Each seal carcass was suspended on a hook that passed between the lower jaw bones and up through the mouth (fig. 3). After the carcass was eviscerated, it was washed and cooled as it moved through a series of salt-water sprinklers. About 360 feet beyond the point where the carcass was hung on a hook, a circular blade severed the head and allowed the carcass to drop into a high-speed grinder (fig. 4).

[1] Special terms used in this report are defined in the glossary.

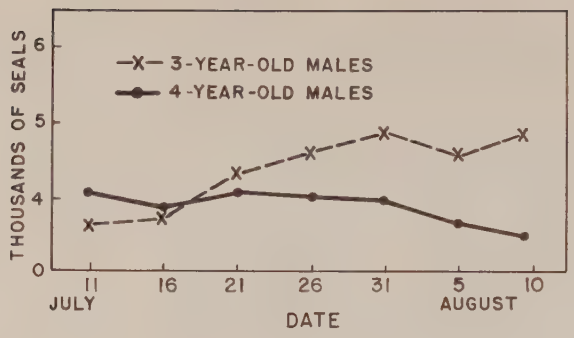


Figure 1.--Kill of 3- and 4-year-old male seals, by 5-day periods, St. Paul Island, 11 July-10 Aug. 1965.

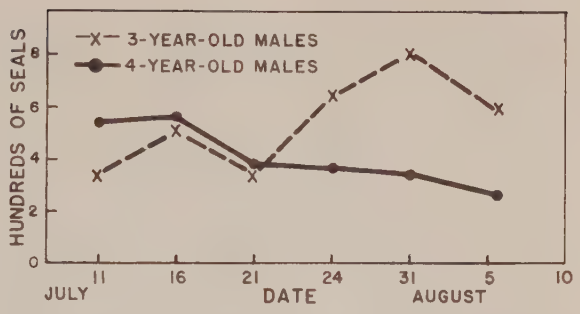


Figure 2.--Kill of 3- and 4-year-old male seals, by varying periods, St. George Island, 11 July-10 Aug. 1965.

Table 1.--Kill of male seals,[1] by year class, Pribilof Islands, Alaska, 1947-63

Year class	St. Paul Island					St. George Island					Grand total
	Age when killed				Total	Age when killed				Total	
	2	3	4	5		2	3	4	5		
1947.....	-----	30,110	23,697	854	54,661	-----	7,043	3,731	123	10,897	65,558
1948.....	486	25,714	19,995	103	46,298	114	5,546	3,926	22	9,608	55,906
1949.....	-----	29,697	12,326	249	42,272	303	7,116	2,570	280	10,269	52,541
1950.....	855	40,656	15,365	332	57,208	1,104	8,475	4,793	147	14,519	71,727
1951.....	1,384	32,350	18,083	3,057	54,874	288	7,907	5,310	681	14,186	69,060
1952.....	1,735	30,733	31,410	675	64,553	545	8,998	8,459	506	18,508	83,061
1953.....	839	38,312	8,855	54	48,060	295	10,611	3,330	100	14,336	62,396
1954.....	2,918	23,473	5,599	554	32,544	535	6,651	2,779	162	10,127	42,671
1955.....	1,015	27,863	10,555	115	39,548	555	7,246	2,825	260	10,886	50,434
1956.....	885	10,671	2,762	532	14,850	171	2,251	1,387	218	4,027	18,877
1957.....	2,590	24,283	15,344	773	42,990	242	5,098	4,492	244	10,076	53,066
1958.....	1,977	48,458	14,149	1,587	66,171	431	9,413	3,707	540	14,091	80,262
1959.....	2,820	26,456	14,184	1,764	45,224	891	5,890	4,690	492	11,963	57,187
1960.....	1,619	14,310	10,533	1,240	27,702	636	4,332	2,579	178	7,725	35,427
1961[2]....	1,098	22,468	12,046	-----	35,612	921	6,948	2,592	----	10,461	46,073
1962[2]....	2,539	19,009	------	-----	21,548	1,139	3,736	-----	----	4,875	26,423
1963[2]....	1,264	------	------	-----	1,264	167	-----	-----	----	167	1,431

[1] Includes only age 2- to 5-year-old seals taken during the male kills on the Pribilof Islands; males taken during the female kills of recent years usually have not been sampled for age.
[2] Incomplete returns.

Table 2.--Dates at which various kill levels of male seals were reached and the corresponding percentage age classification, St. Paul Island, 1954-65

Date	Cumulative total kill	Age in years		
		3	4	2, 5, and 6
	Number	Percent	Percent	Percent
1954:				
4 July	10,000	44	54	2
11 do	20,000	49	49	2
18 do	30,000	56	41	3
27 do	49,699	65	31	4
1955:				
9 do	10,000	50	48	2
16 do	20,000	53	46	1
22 do	30,000	56	42	2
31 do	49,977	62	36	2
1956:				
6 do	10,000	24	64	12
11 do	20,000	30	62	8
16 do	30,000	33	60	7
26 do	50,000	41	52	7
15 Aug	75,736	51	42	7
1957:				
13 July	10,000	53	41	6
24 do	20,000	63	33	4
5 Aug	30,000	67	28	5
10 do	34,055	69	26	5
1958:				
10 July	10,000	74	26	----------
18 do	20,000	78	22	----------
28 do	30,000	80	19	1
31 do	33,325	82	17	1
1959:				
14 do	10,000	38	57	5
27 do	20,000	45	50	5
31 do	22,286	46	47	7
1960:				
21 do	10,000	80	17	3
1 Aug	20,000	83	12	5
7 do	28,819	84	10	6
1961:				
9 July	10,000	61	37	2
18 do	20,000	62	37	1
24 do	30,000	66	32	2
2 Aug	50,000	70	27	3
15 do	67,169	72	23	5
1962:				
12 July	10,000	49	47	4
20 do	20,000	54	42	4
26 do	30,000	59	37	4
5 Aug	39,983	62	34	4
1963:				
16 July	10,000	33	59	8
25 do	20,000	43	50	7
5 Aug	30,000	47	46	7
1964:				
15 July	10,000	48	43	9
24 do	20,000	55	36	9
2 Aug	30,000	59	31	10
5 do	32,712	60	29	11
1965:				
19 July	10,000	44	50	6
29 do	20,000	51	43	6
8 Aug	30,000	56	37	7
9 do	31,055	56	36	8

Table 3.--Cumulative number of male seals killed, St. Paul Island, 1955-65[1]

Date	Age in years	
	3	4
1955:		
1 July	1,574	1,962
6 do	3,341	3,643
11 do	5,929	6,248
16 do	10,416	8,999
21 do	15,358	11,648
26 do	21,707	15,638
31 do	30,733	18,083
1956:		
1 July	1,079	3,056
6 do	2,671	7,060
11 do	6,145	12,677
16 do	9,808	17,954
21 do	14,589	22,159
26 do	20,726	25,999
31 do	26,590	28,560
5 Aug	31,701	29,853
10 do	35,502	30,663
15 do	38,290	31,448
1957:		
1 July	1,360	1,071
6 do	2,994	2,161
11 do	4,507	3,296
16 do	6,777	4,651
21 do	9,380	5,602
26 do	13,350	6,784
31 do	16,804	7,547
5 Aug	19,823	8,196
10 do	23,473	8,855
1958:		
1 July	1,991	732
6 do	3,988	1,383
11 do	8,038	2,658
16 do	12,917	3,912
21 do	17,688	4,839
26 do	22,661	5,279
31 do	27,216	5,556
1959:		
1 July	584	1,474
6 July	1,364	3,028
11 do	2,625	4,665
16 do	4,189	6,425
21 do	6,096	7,949
26 do	8,327	9,721
31 do	10,203	10,446
1960:		
1 July	699	368
6 do	1,751	676
11 do	3,274	988
16 do	5,529	1,385
21 do	7,904	1,717
26 do	10,978	1,968
31 do	15,312	2,347
5 Aug	21,610	2,657
10 do	24,201	2,757
1961:		
6 July	4,119	2,315
11 do	6,770	4,316
16 do	9,993	6,021
21 do	15,492	8,302
26 do	22,609	10,851
31 do	29,523	12,488
5 Aug	38,908	14,072
10 do	43,629	14,780
15 do	48,458	15,344
1962:		
6 July	1,639	2,028
11 do	4,485	4,335
16 do	7,643	6,636
21 do	11,226	8,663
26 do	17,301	10,832
31 do	20,267	12,047
5 Aug	25,098	13,422
1963:		
6 July	1,381	2,668
11 do	2,498	4,331
16 do	3,155	5,531
21 do	6,047	7,882
26 do	8,915	10,373
31 do	11,596	12,283
5 Aug	13,954	13,791
1964:		
6 July	1,819	2,095
11 do	3,266	3,482
16 do	5,619	4,968
21 do	9,333	6,710
26 do	13,188	8,279
31 do	17,607	9,624
5 Aug	22,203	10,509
1965:		
11 July	1,228	2,050
16 do	2,637	3,729
21 do	5,236	5,873
26 do	8,436	7,883
31 do	12,126	9,838
5 Aug	15,246	11,115
10 do	19,009	12,046

[1] Sealing began 2 July in 1961, 1962, and 1963; 1 July in 1964; 7 July in 1965; 27 June all other years. Kill of males ended on the following dates: 31 July 1955; 15 Aug. 1956; 10 Aug. 1957; 31 July 1958-59; 7 Aug. 1960; 15 Aug. 1961; 5 Aug. 1962-64; and 9 Aug. 1965.

Figure 3.--Laborers hanging seal carcasses on hooks, byproducts plant, St. Paul Island, 1965 (photo by Harry W. May).

Figure 4.--Carcasses being separated from heads over grinder, byproducts plant, St. Paul Island, 1965 (photo by Harry W. May).

Collection of canine teeth, recovery of tags, and recording of checkmarks were done midway between the sprinklers and the grinder. Standing on a platform 3 feet high, one man used a hack saw to remove the snouts just anterior to the eyes (fig. 5). From this position, the snouts passed the worker at eye level. Twenty percent or more of the seals were sampled daily for right upper canine teeth by taking the snouts from carcasses 1 and 2, 11 and 12, 21 and 22, etc., until all seals killed that day had passed. Another man examined left front flippers for tags and checkmarks as he walked in a direction opposing that of the moving line of carcasses (fig. 6). When he reached the sprinklers, the worker inserted a marker into the last carcass examined, crossed to the other side of the line, and examined the right front flippers as he returned to the carcass with which he began. Examination of about 100 seals in 10 minutes was followed by a wait of 15 minutes, after which the worker repeated the procedure, beginning with the last carcass he had marked. During the 15-minute interval, the tag-recovery man examined loose flippers at the carcass dumping site or assisted the tooth collector.

Bull counts.--The number of harem bulls (adult males holding females) counted on the Pribilof Islands has decreased each year since 1961 (fig. 7). The number of harem bulls depends on the numerical strength of two other herd elements--idle or reserve bulls (males age 7 and older without females) and producing females. Decreases in the number of harem bulls, however, are believed to be the result of the reduction in the number of producing females.

The number of idle bulls counted on land has also been decreasing, following a sharp rise from 1952 to 1960 (fig. 7). The decline in idle bulls has been caused by extensive killing of recent year classes through longer seasons and increases in the maximum size of seals taken.

The counts of bulls in 1965 are given by island and by rookery in appendix table 10, and all counts of bulls since 1911 are presented in appendix table 11.

Females

The maximum sustained yield of sealskins should occur when the number of breeding females is at some level below its natural peak. For this reason, large numbers of females were purposely killed on the Pribilof Islands from 1956 through 1963 to reduce the population from the peak reached by about 1940 to a lower and more productive level. Additional females were taken in 1964 and

Figure 5.--Biological assistant taking tooth samples, byproducts plant, St. Paul Island, 1965 (photo by Harry W. May).

Figure 6.--Biologist examining seals for tags and checkmarks, byproducts plant, St. Paul Island, 1965 (photo by Harry W. May).

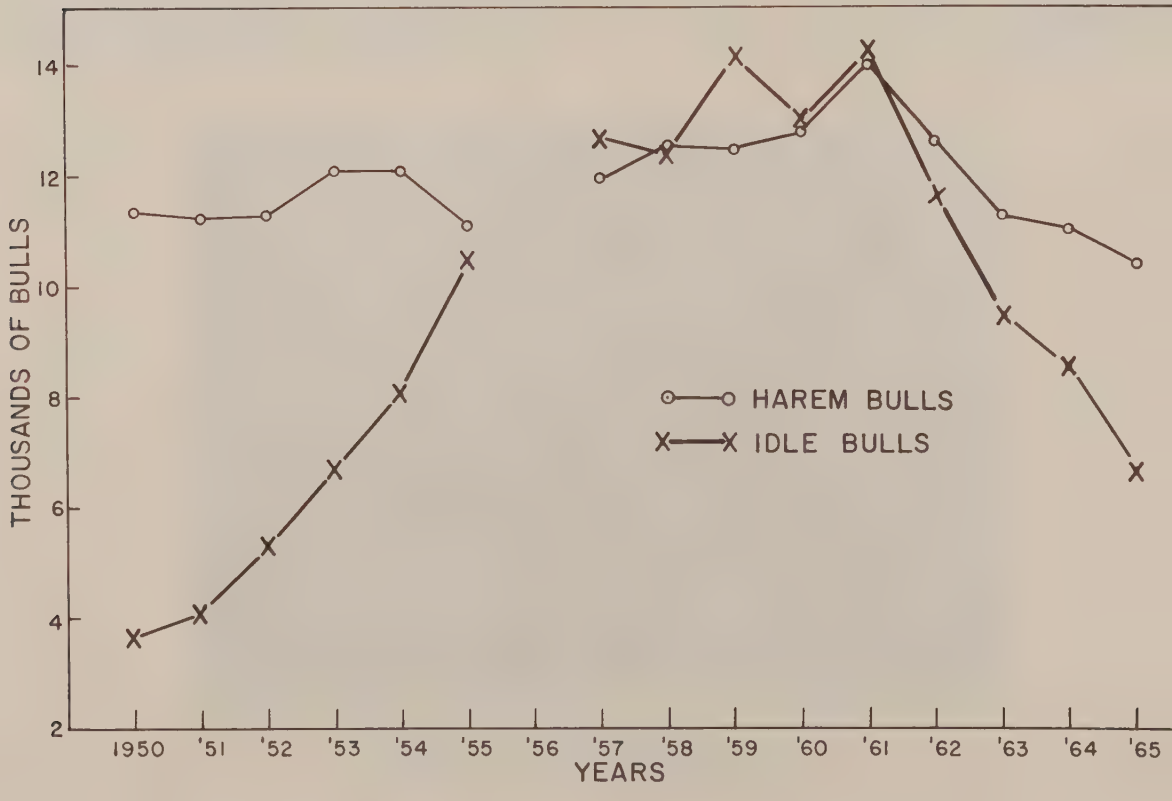


Figure 7.--Counts of harem and idle bulls, Pribilof Islands, Alaska, 1950-55 and 1957-65.

1965 to maintain the population at the level achieved.

A total of 10,432 females were taken from the hauling grounds of the Pribilof Islands in 1965. Of these, 3,868 were taken during the kill of male seals 7 July to 9 August and 6,564 during the special kill of females 16-27 August. The female seals killed in 1965 are classified by age in appendix tables 12, 13, 14, and 15. Year class contributions to the kill of females are given in table 4, and the percentage age composition of females sampled from the kills on the Pribilof Islands in 1958-65 are presented in table 5.

Once the females attain sexual maturity and join the breeding element of the herd, they are subjected to bite wounds from the harem bulls. The resulting scars lessen the commercial value of their skins. Most of the females are initially exposed to scarring at age 5 or 6, when they enter the rookeries to give birth to their first pup. The skins from females age 5 and younger, therefore, are more valuable than those from females age 6 and older.

In addition to being relatively free of scars, females age 5 and younger usually have black or a mixture of black and white vibrissae. By comparison, most females age 6 and older have white vibrissae. Thus, females having the most valuable skins can be selected for killing on the Pribilof Islands on the basis of vibrissal color. In 1965, selection was practiced on St. Paul Island 23-27 August; 88 percent of the females taken were age 5 and younger. On St. George Island, where selection was not practiced 16-27 August, only 64 percent of the females killed were age 5 and younger.

Tag Recoveries and Tagging

Tagging provides marked seals needed for making estimates of the population and furnishes seals of known age and origin of birth for studies of age and growth, distribution at

Table 4.--Kill of female seals, by year class,[1] Pribilof Islands, Alaska, 1939-64

Year class	Age in years									
	1	2	3	4	5	6	7	8	9	10
1939	------	------	------	------	------	------	------	------	------	17
1940	------	------	------	------	------	------	------	------	8	15
1941	------	------	------	------	------	------	------	16	7	15
1942	------	------	------	------	------	------	15	13	7	39
1943	------	------	------	------	------	12	8	10	41	36
1944	------	------	------	------	3	11	9	57	43	10
1945	------	------	------	4	4	8	45	43	11	27
1946	------	------	------	4	4	60	54	11	38	762
1947	------	1	------	1	37	84	46	48	1,136	1,773
1948	------	------	------	84	75	94	77	1,766	3,120	678
1949	------	------	30	34	161	118	2,155	3,550	559	1,173
1950	------	10	17	92	210	2,949	4,031	654	1,289	345
1951	4	------	8	85	4,618	6,343	1,328	1,958	492	2,292
1952	------	------	16	6,422	11,465	3,408	3,515	526	3,127	1,687
1953	------	1	2,132	5,806	4,056	2,958	493	2,843	2,247	87
1954	------	132	1,150	8,493	3,771	683	3,057	2,809	68	51
1955	------	11	11,468	7,285	1,047	4,810	2,869	97	34	16
1956	------	601	2,072	614	4,520	3,444	1,859	42	16	
1957	150	281	352	6,912	6,303	4,080	592	33		
1958	76	79	4,651	8,683	8,697	1,914	383			
1959	27	508	4,563	8,044	3,626	621				
1960	120	431	2,979	3,409	1,121					
1961	37	724	3,434	2,629						
1962	7	390	1,384							
1963	26	172								
1964	12									

[1] Includes pelagic research kill of the United States and Canada, 1958-65. In addition to the above kill, 50,541 females age 11 and older, 19,978 females age 8 and older, and 6,261 unclassified females were taken.

Table 5.--Percentage age composition of female seals sampled from the kills, Pribilof Islands, Alaska, 1958-65

Year and island	Age in years									
	2	3	4	5	6	7	8	9	10	10+
1958:										
St. Paul	2	37	29	13	11	3	1	1	2	1
St. George	1	20	22	17	13	9	4	3	2	9
1959:										
St. Paul	1	6	25	14	11	12	6	4	4	17
St. George	---	6	20	14	10	13	7	6	5	19
1960:										
St. Paul	1	8	14	23	14	9	8	7	4	12
St. George	---	3	9	20	12	8	10	9	5	24
1961:										
St. Paul	1	10	16	10	11	6	6	7	5	28
St. George	1	11	15	10	10	7	6	7	6	27
1962:										
St. Paul:										
July-August	1	14	26	15	6	5	4	3	3	23
September	---	2	9	13	10	9	10	8	4	35
St. George	1	12	24	14	8	5	5	3	3	25

	Age in years						
	2	3	4	5	6	7	8+
1963:							
St. Paul:							
July-August	1	5	18	21	10	4	41
September	3	7	14	17	8	5	46
St. George	2	10	23	18	10	4	33
1964:							
St. Paul	3	21	22	23	13	4	14
St. George	2	29	24	28	10	2	5
1965:							
St. Paul	4	25	44	15	5	4	3
St. George	1	14	31	18	14	8	14

sea, homing tendency, and commercial value of skins by age and sex. Fur seal pups of both sexes have been tagged and checkmarked nearly every year on St. Paul Island since 1947 and on St. George Island since 1956. Yearling fur seals, primarily males, were first tagged in 1961. This section gives the number of tags and marks recovered from male and female seals killed on the Pribilof Islands in 1965 and discusses the techniques that were used in tagging and marking pups and in selecting yearlings for tagging on St. Paul Island.

Tag recoveries.--Tagged seals killed in 1965 were taken only if within the limits set for killing all seals. The limits for taking males on both Islands were from 42.0 inches (106.7 cm.) long to, but not including, those with manes. All females driven with the males were taken. During the special kill of females on St. Paul Island 23-27 August, only those with black or mixed black and white vibrissae were killed. All females driven during the special kill of females on St. George Island 16-27 August were taken, regardless of vibrissal color. Possibly a few of the 65 tagged seals taken on St. Paul for studies of fur value by age and sex were outside the prescribed limits.

A total of 2,736 tags were recovered from male seals in ages 2-10, and 1,508 checkmarks were recorded from males that had lost their tags (table 6).

A total of 463 tags were recovered from females in ages 2-17, and 240 checkmarks were recorded from females in ages 2-6. Checkmarks from females age 7 and older were not recorded because each of the four front flipper marks used since 1953 (app. table 18) has been repeated every fourth year. Thus, the location and type of checkmarks on females age 7 and older may be identical on animals of different ages. Checkmarked females (as well as males) 2 and 6 years old can be separated on the basis of body size.

A total of 238 seals selected as yearlings on the basis of body length and double-tagged on St. Paul Island in 1961 (M-series), 1962 (N-series), and 1963 (O-series) were recovered on the Pribilof Islands in 1965 (table 7).

Thirty-six seals tagged by the U.S.S.R. were killed on the Pribilof Islands in 1965 (table 8 and app. table 16).

Tagging and marking of pups.--Pups were not tagged or marked on St. George Island in 1965.

On St. Paul Island, 30,000 pups were tagged and marked, or marked only, as follows: (1) Tags were attached to the left front flipper of 10,000 pups between the fourth and fifth digits, and a V-notch checkmark was cut into the leading edge of the same flipper with veterinary ear-notching instruments; (2) 10,080 pups were marked only by removing the tip of the first digit (big toe) of the right hind flipper at the web; and (3) 10,007 pups were marked only by cutting a V-notch into the leading edge of the right front flipper. The tagging and marking were completed in 8 days by 11 men. Example of tag and mark locations used on fur seal pups are illustrated in figure 8.

The veining chisels formerly used to make the V-notch checkmarks were replaced in 1962 with veterinary ear-notching instruments. The latter tool is superior because it is easier to use, does not require a surface such as wood to cut against, is adjustable for horizontal depth of cut, and remains sharp during thousands of cuts; furthermore, it makes consistently good marks such as that shown in figure 9, whereas the veining chisels tended to slip off the edge of the flipper and leave only a faint and unrecognizable checkmark. Figure 10 illustrates a few of the checkmarks made by veterinary ear-notching instruments in 1962 and recovered from tagged 3-year-old males in 1965. Of 279 tagged seals examined, 266 had checkmarks that were easily recognizable; only 13 of the tagged seals did not have recognizable checkmarks.

All tags used since 1952 have been attached to front flippers, and most have been attached to the front flipper at the hairline (fig. 8); however, in 1964, a new tagging site located between the fourth and fifth digits (fig. 8) was used for half (10,000) of the pups tagged. The new site was used on all pups tagged in 1965 to lessen damage by tagging. The effectiveness of the new tagging site is not yet known.

The number of pups tagged in 1965 is listed in appendix table 17 by rookery, and a record of pups tagged on the Pribilof Islands since 1941 is given in appendix table 18.

Tagging of yearlings.--The methods used to select and tag yearlings in 1965 were nearly the same as in 1962 and 1963. The upper length limit was reduced from 37.5 inches (95 cm.) to 35.0 inches (89 cm.) for females after the second day of tagging in 1965 to prevent selection of females older than age 1 for tagging. Body length has proved to be a good basis for selecting yearling males; it is not suitable for identifying yearling females, however (see section on estimates based on recoveries of tags applied to yearlings), because of the greater overlap in lengths among 1-, 2-, and even 3-year-old females. An upper body-length limit of 39.5 inches (100 cm.) has been used successfully to separate yearling males from older males. The length-frequency distributions of known-age yearling males tagged as pups and males selected as yearlings on the basis of body length are similar (fig. 11); the mean lengths of the two differ by only 1 cm. (table 9).

The surveys for known-age yearlings tagged as pups, begun in 1963, were discontinued in 1965 because it was impossible to tag yearlings and make surveys during the same period. Also, no apparent way existed to standardize the survey work from year to year.

Most of the yearlings found in 1965 were on hauling grounds on Zapadni Reef and south of Sea Lion Neck.

In previous years, the hauling ground areas most used by yearlings were examined in 1 day. In 1965, however, seals were so abundant on the hauling grounds that it was impossible to examine all areas in less than 2 days. Possibly weather caused more animals to be on the hauling grounds in 1965 than in other years. The weather during tagging was windy with occasional snow. The relation between weather and the location of yearlings, however, is not clear.

Six men tagged 991 yearlings in 7-1/2 days in 1965 (app. table 19).

Pup Mortality

The number of dead pups counted in 1965 was 181 percent of the number counted in 1964 on St. Paul Island and 219 percent on St. George Island. The counts for both Islands are illustrated in figure 12 for 1950-65 and given in detail in appendix table 20 for 1941-65.

Table 6.--Summary of tagged and lost-tag seals recovered, by age and sex, Pribilof Islands, Alaska, 1965

Series	Age	Tagged seals			Lost-tag seals			Grand total
		St. Paul Island	St. George Island	Combined total	St. Paul Island	St. George Island	Combined total	
	Years	7 July to 9 August Males						
P.....	2	53	5	58	57	3	60	118
O.....	3	1,393	262	1,655	748	29	777	2,432
N.....	4	730	150	880	534	28	562	1,442
M.....	5	73	13	86	87	9	96	182
L.....	6	11	3	14	3	1	4	18
K.....	7	2	----------	2	1	----------	1	3
J.....	8	1	----------	1	--------	----------	-------	1
H.....	10	1	----------	1	--------	----------	-------	1
Total.....		2,264	433	2,697	1,430	70	1,500	4,197
		Females						
P.....	2	--------	----------	-------	13	----------	13	13
O.....	3	--------	----------	-------	9	----------	9	9
N.....	4	9	1	10	17	----------	17	27
M.....	5	17	3	20	12	----------	12	32
L.....	6	15	1	16	3	----------	3	19
K.....	7	20	----------	20	--------	----------	-------	20
J.....	8	8	----------	8	--------	----------	-------	8
I.....	9	2	1	3	--------	----------	-------	3
H.....	10	7	----------	7	--------	----------	-------	7
G.....	11	1	----------	1	--------	----------	-------	1
E.....	13	2	----------	2	--------	----------	-------	2
Total.....		81	6	87	54	----------	54	141
		16-27 August Males						
P.....	2	6	5	11	4	1	5	16
O.....	3	4	23	27	1	1	2	29
N.....	4	--------	1	1	--------	----------	-------	1
M.....	5	--------	----------	-------	1	----------	1	1
Total.....		10	29	39	6	2	8	47
		Females						
P.....	2	10	----------	10	32	----------	32	42
O.....	3	83	44	127	46	9	55	182
N.....	4	92	70	162	45	8	53	215
M.....	5	14	37	51	38	6	44	95
L.....	6	3	13	16	--------	2	2	18
K.....	7	2	2	4	--------	----------	-------	4
J.....	8	1	----------	1	--------	----------	-------	1
H.....	10	2	----------	2	--------	----------	-------	2
E.....	13	2	----------	2	--------	----------	-------	2
B.....	17	1	----------	1	--------	----------	-------	1
Total.....		210	166	376	161	25	186	562

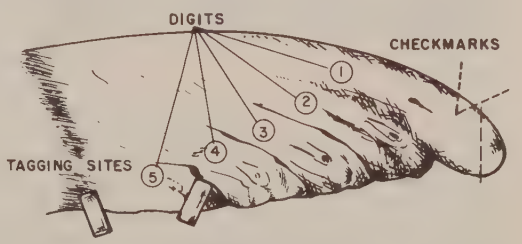
Table 7.--Tag recoveries in 1965 from seals selected and tagged as yearlings, Pribilof Islands, Alaska

Series	Age when:		St. Paul Island		St. George Island		Total	
	Tagged	Recovered	Males	Females	Males	Females	Males	Females
	Years	Years	Number	Number	Number	Number	Number	Number
			Male kill (7 July to 9 August)					
M.....	1	5	1	---	---	---	1	---
	2	6	1	---	---	---	1	---
Total			2	---	---	---	2	---
N.....	1	4	72	---	2	---	74	---
	2	5	---	---	1	---	1	---
	Unknown[1]		7	---	---	---	7	---
Total			79	---	3	---	82	---
O.....	1	3	119	---	11	---	130	---
	2	4	8	---	---	---	8	---
	Unknown[1]		8	---	---	---	8	---
Total			135	---	11	---	146	---
			Female kill (16-27 August)					
N.....	1	4	---	2	---	1	---	3
	2	5	---	---	---	---	---	---
Total			---	2	---	1	---	3
O.....	1	3	1	---	1	1	2	1
	2	4	---	1	---	---	---	1
	Unknown[1]		---	1	---	---	---	1
Total			1	2	1	1	2	3

[1] Tags were recovered but the canine teeth for determining age were not.

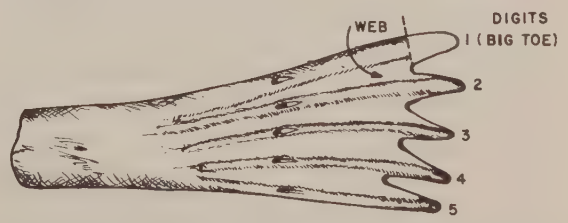
Table 8.--Summary of Soviet tags recovered from the kill, Pribilof Islands, Alaska, 1965

Age	St. Paul Island		St. George Island	
	Male	Female	Male	Female
Years	Number	Number	Number	Number
2.....	5	------	------	-------
3.....	15	2	4	-------
4.....	1	------	3	-------
5.....	5	------	------	-------
7.....	------	1	------	-------
Total.....	26	3	7	-------



FRONT FLIPPER

ILLUSTRATION SHOWING TAGS CLINCHED AT THE HAIRLINE AND BETWEEN THE FOURTH AND FIFTH DIGITS. ALSO SHOWN ARE TWO CHECKMARKS, A V-NOTCH NEAR THE TIP AND THE TIP SLICED OFF.



HIND FLIPPER

ILLUSTRATION SHOWING A FLIPPER CHECKMARKED BY REMOVING ABOUT TWO INCHES OF THE BIG TOE OR FIRST DIGIT.

Figure 8.--Examples of tag and mark locations that have been used since 1940 on fur seal pups, Pribilof Islands, Alaska.

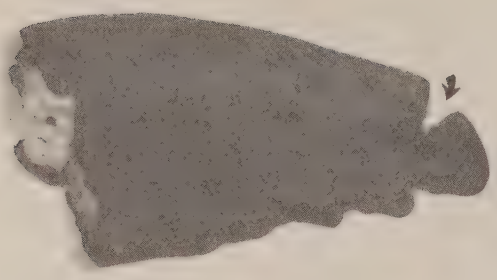


Figure 9.--V-notch mark applied to pups and used subsequently to identify age when the seal has lost its tag, or was V-notched only. This mark was photographed soon after it was made with a veterinary ear-notching instrument.

Figure 10.--V-notch checkmarks applied to pups in 1962 with veterinary ear-notching instruments and recovered from tagged 3-year-old males in 1965. Of 279 checkmarks examined, 95 percent were similar to those in the top row, and 5 percent resembled those in the bottom row. Examination of thousands of seals has shown that the marks in the top row cannot be confused with accessory or naturally occurring marks. The marks in the bottom row would not have been recognized if the seals had not been tagged; these marks are assumed to be checkmarks.

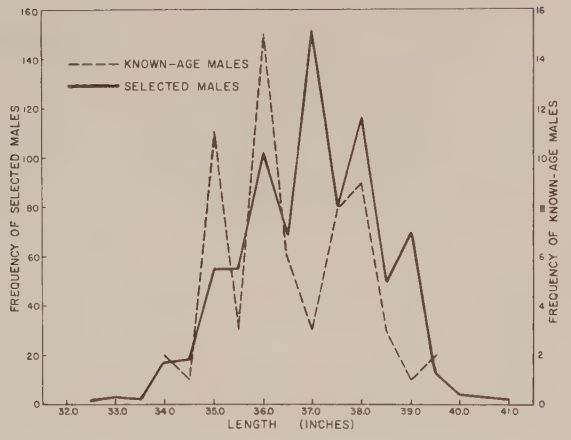


Figure 11.--Body lengths of known-age yearling males and males selected as yearlings on the basis of body length, St. Paul Island, 1965.

Pup Weights

Seal pups have been weighed on St. Paul Island annually about 1 September since 1957 to determine if body weight of untagged pups in autumn is related to survival. A consistent relation would be useful in predicting the returns (kill) from a year class. The data obtained to date are discussed in appendix A.

The weighing program has also provided information on the effects of tagging and marking pups. Each year since 1957, untagged and unmarked pups have been heavier than tagged and marked pups 1 or 2 weeks after tagging (app. table 21). The mean weights of untagged and unmarked males and females in 1965 were 1.14 and 1.04 kg. more than tagged and marked males and females. This difference in weight may cause tagged and marked pups to die at a greater rate than untagged and unmarked pups during their first winter at sea. If true, then subsequent estimates of the population based on recoveries of tags and marked seals are inflated.

The tip of the big toe or first digit (fig. 10) on the right hind flipper of each of 10,080 pups was removed as part of the pup tagging

Table 9.--Summary of data from tagging of yearlings, St. Paul Island, 1965

Item	Males			Females		
	Tagged as pups[1]	Untagged	Total	Tagged as pups[1]	Untagged	Total
Number tagged	64	809	873	5	113	118
Mean length (cm.)[2]	93	94	--------	90	90	--------

[1] Animals bearing tags or checkmarks applied in year of birth.
[2] Length was taken to nearest half inch, then converted to centimeters.

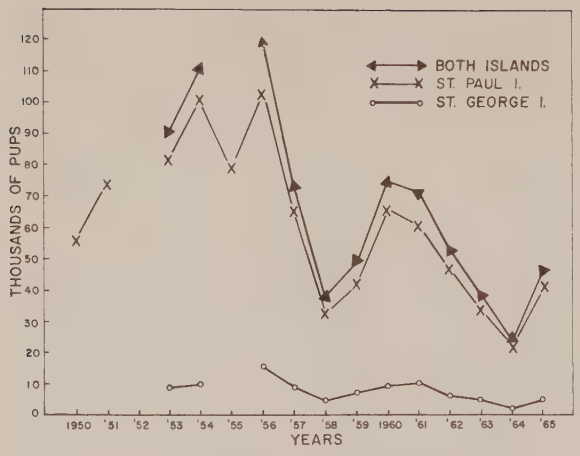


Figure 12.--Counts of dead pups, Pribilof Islands, Alaska, 1950-51 and 1953-65.

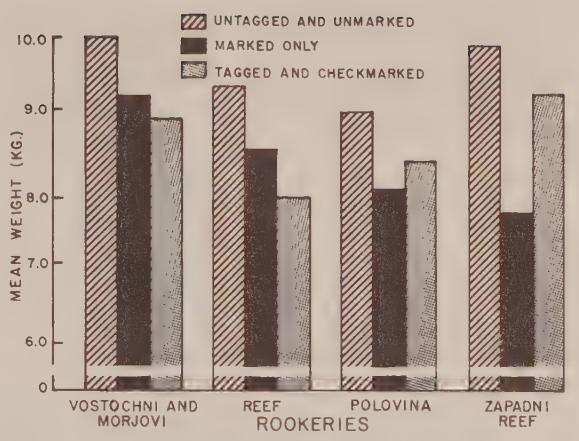


Figure 13.--Mean weights of seal pups about 1 September, St. Paul Island, 1965.

and marking program on St. Paul Island in 1965. Untagged pups with this mark weighed more than tagged and marked pups but less than untagged and unmarked pups on two of the four rookeries where pups were weighed (fig. 13 and app. table 22). On Zapadni Reef and Polovina rookeries, untagged pups bearing the first digit mark were lighter than tagged and marked or untagged and unmarked pups. An analysis of variance test adjusted for disproportionate subclass sizes showed that the interaction for rookeries versus type of mark was significant ($P<0.01$). The main effects were not tested because of the significant interaction. On all rookeries, untagged and unmarked seals were heavier than tagged and marked seals or seals with marks only, and males were heavier than females.

The use of scales that were too sensitive to the movement of pups during weighing has been a constant problem since the weighing began. In 1957 and 1958, a metal cone for holding the pups was attached to a dial spring scale suspended from a wooden tripod. The spring scale, however, was too sensitive to movement of the pups, and the cone caused the pups to move considerably in their attempts to escape. Both problems were partially solved in 1959 by putting the pups in burlap bags sewed to construction-steel hoops and placing the bag containing the pup on a platform scale. Though the platform scale had no dampeners, it was less sensitive than the spring scale to movement of the pups, and the pups were less inclined to struggle when confined in the bag. The bags, however, changed in weight as they dried or absorbed rainwater. Frequent weighing of the bags and corresponding adjustments of the scale eliminated much of the error from this source. In 1963 and 1964, the same platform scale was used, but the pups were placed in 20-gallon plastic garbage cans. The pups tended to move more when in this container than when confined in the burlap bags. The method of holding the pups, therefore, was changed in 1965 and a new platform scale, with dampeners, was used. One man stood on the scale and held each pup during weighing, a method that effectively eliminated movement of the pups. The weight of the man was recorded after each series of 25 weighings, for later subtraction.

Barricades for holding small groups of pups for weighing have been used each year, and weighed pups have been released 50-75 feet from the site of weighing so that they would not be weighed twice. Weights were recorded to the nearest 0.2 kg. from 1957-64 and to the nearest 0.5 kg. in 1965.

Population Estimates

This section presents estimates of the population based on the most recent data. Methods used and sources of data have been described by: Roppel, Johnson, Bauer, Chapman, and Wilke (1963); Roppel, Johnson, and Chapman (1965); and Roppel, Johnson, Anas, and Chapman (1965).

Estimates based on tag recoveries.--The number of pups born, as estimated from tag recoveries (includes tagged and lost-tag seals) from both sexes, are presented in tables 10 through 14. To show within-season variability, the data were divided into 5-day periods and estimates were based on recoveries from 3- and 4-year-old males for each period (table 12). No apparent reason exists for the much greater variability in estimates based on recoveries from 4-year-old males. Estimates based on recoveries from females show considerable year-to-year variation and generally are much lower than estimates based on recoveries from males. For these reasons the data for the sexes have not been combined.

Table 10.--Estimates of the pup population based on tag recoveries from males, year classes 1960-63, Pribilof Islands, Alaska

[n = males killed from each year class; t = tags applied to each year class; s = tag recoveries from males from each year class; N = estimate of year-class size at time of tagging]

Year class	Killed 7 July to 9 August 1965 (n)	Tagged (t)	Tag recoveries (s)	Population estimate (N)
	Number	Number	Number	Number
1960	1,418	59,981	182	465,106
1961	14,638	49,921	[1] 1,524	479,218
1962	22,745	49,908	[1] 2,544	446,063
1963	1,431	24,971	118	300,503

[1] Lost-tag recoveries on St. George Island were corrected by the ratio of lost-tag to tagged pups observed on St. Paul Island.

Table 11.--Estimates of the pup population based on tag recoveries from 3- and 4-year-old males, year classes 1958-62, Pribilof Islands, Alaska

[n = 3- and 4-year-old males killed from each year class; t = tags applied to each year class; s = tag recoveries from 3- and 4-year-old males from each year class; N = estimate of year-class size at time of tagging]

Year class	Killed at ages 3 and 4 (n)	Tagged (t)	Tag recoveries (s)	Population estimate (N)
	Number	Number	Number	Number
1958	74,890	49,917	5,409	691,018
1959	48,596	49,881	3,324	729,057
1960	31,059	59,981	3,279	568,000
1961	43,465	49,921	4,432	489,490
1962[1]	22,745	49,908	2,544	446,063

[1] Age 3 only.

Table 12.--Estimates of the pup population based on tag recoveries from 3- and 4-year-old males, by 5-day periods, year classes 1961-62, Pribilof Islands, Alaska

[n = males killed each period; t = tags applied to year class; s = tag recoveries each period; N = estimate of year-class size at time of tagging]

Date	Age 3 (year class 1962)				Age 4 (year class 1961)			
	Killed (n)	Tagged (t)	Tag recoveries[1] (s)	Population estimate (N)	Killed (n)	Tagged (t)	Tag recoveries[1] (s)	Population estimate (N)
July:	Number	Number	Number	Number	Number	Number	Number	Number
7-11	1,576	49,908	193	405,704	2,587	49,921	243	529,501
12-16	1,904	------	207	457,099	2,236	------	194	572,695
17-21	2,941	------	316	463,193	2,526	------	294	427,637
22-26	3,842	------	410	466,667	2,381	------	234	506,018
27-31	4,487	------	483	462,793	2,304	------	219	523,046
Aug:								
1-5	3,713	------	440	420,322	1,545	------	159	482,371
6-9	4,282	------	495	430,968	1,059	------	181	290,755
Total	22,745	------	2,544	446,063	14,638	-------	1,524	479,218

[1] Lost-tag recoveries on St. George Island were corrected by the ratio of lost-tag to tagged pups observed on St. Paul Island.

Table 13.--Estimates of the pup population based on tag recoveries, year classes 1951-63, Pribilof Islands, Alaska

Year class	Pups alive at time of tagging	Dead pups counted	Pups born
	Number	Number	Number
1951.....	484,000	86,000	570,000
1952.....	529,000	87,000	616,000
1953.....	704,000	91,000	795,000
1954.....	727,000	111,000	838,000
1955.....	778,000	90,000	868,000
1956.....	872,000	120,000	992,000
1957.....	637,000	75,000	712,000
1958.....	691,000	38,000	729,000
1959.....	729,000	49,000	778,000
1960.....	568,000	75,000	643,000
1961.....	489,000	71,000	560,000
1962.....	446,000	54,000	500,000
1963.....	[1] 301,000	39,000	340,000

[1] A preliminary estimate based on tag recoveries at age 2 only.

The number of pups born, as estimated from tag recoveries, has decreased steadily from 778,000 in 1959 to 340,000 in 1963 (table 13).

Estimates of the number of yearling males are available for the 1961 and 1962 year classes (table 15). These animals were tagged as yearlings in late September and October of 1962 and 1963. The errors in selection (by length) of yearling males for tagging, calculated from age of animals taken later in the kill, were 2.9 and 5.5 percent for the 1961 and 1962 year classes, respectively. Age was determined for 346 tagged males recovered from the 1961 year class and 199 tagged males recovered from the 1962 year class. The estimates based on recoveries at ages 2, 3, and 4 increased with the increase in age. The reason for the increase is not known. The recoveries from females are too few to provide a basis for estimates.

Estimates based on sampling live pups.--The methods used in shearing and sampling pups on St. Paul Island were described by Roppel, Johnson, and Chapman (1965), and Roppel, Johnson, Anas, and Chapman (1965).

A total of 25,868 pups were sheared on St. Paul Island in 1965. As in previous years, the shearing and sampling method was tested for consistency of results by sampling the pups on each rookery twice, and obtaining ratios of sheared to unsheared seals from groups of 25 pups each time. The resulting estimates--208,468 and 200,821--were similar (table 16). An additional estimate of 247,960 was made by finding the ratio of sheared to unsheared pups in groups of 100 on all rookeries (table 17).

The accuracy of estimates obtained from sampling live pups was checked by making total counts on three small rookeries and part of a large one (table 18). The estimates based on sampling by groups of 25 usually were lower than the total counts. The estimates based on sampling by groups of 100, however, were higher than the counts on the small rookeries but lower than the count on the large rookery. The mean of the three estimates (two based on samples of 25 and one on samples of 100) was in good agreement with the counts for the smaller areas, but was only 86 percent of the count on the large area. The number of pups born, as estimated by the two sampling methods, is given by rookery in table 19. When corrected by the average difference between estimates and counts (estimate = 91.3 percent of the count), the mean of the three estimates gives 247,500 as the number of pups alive on

Table 14.--Estimates of the pup population based on tag recoveries from females, year classes 1960-62, Pribilof Islands, Alaska

[n=females killed from each year class; t=tags applied to each year class; s=tag recoveries from each year class; N=estimate of year-class size at time of tagging]

Year class	Females killed 16-27 August (n)	Tagged (t)	Tag recoveries[1] 16-27 August (s)	Population estimate (N)
	Number	Number	Number	Number
1960.....	1,089	59,981	189	344,107
1961.....	2,556	49,921	241	527,482
1962.....	1,336	49,908	197	337,012

[1] Lost-tag recoveries on St. George Island were corrected by the ratio of lost-tag to tagged pups observed on St. Paul Island.

Table 15.--Estimates of the yearling male population based on tags recovered from seals selected and tagged as yearlings, year classes 1961-62, Pribilof Islands, Alaska

[n = males killed each year from the year class; s = tag recoveries in each year; t = tags applied to yearling males of each year class; N = estimate of yearling males in each year class]

Year	Age	Males killed (n)	Tag recoveries (s)	Yearling males tagged (t)	Estimate of yearling males (N)
	Years	Number	Number	Number	Number
1961 year class, N-series tags:				603	
1963	2	2,019	44		27,113
1964	3	28,827	227		76,369
1965	4	14,638	81		107,829
Pooled		45,484	352		77,827
1962 year class, O-series tag:				520	
1964	2	2,726	42		33,041
1965	3	22,745	138		85,257
Pooled		25,472	180		73,323

Table 16.--Estimates of the pup population based on marked-to-unmarked ratios obtained by sampling groups of 25 after shearing, year class 1965, St. Paul Island

Rookery	Pups sheared	First sampling period, 3-4 August			Second sampling period, 12-13 August			Mean of two estimates
		Samples	Sheared to total counted	Estimated pup population at time of shearing	Samples	Sheared to total counted	Estimated pup population at time of shearing	
	Number	Number	Ratio	Number	Number	Ratio	Number	Number
Gorbatch	2,060	76	245/1900	15,976	50	144/1250	17,882	16,929
Reef	3,559	128	397/3200	28,687	105	318/2625	29,378	29,032
Ardiguen	316	10	40/250	1,975	9	21/225	3,386	2,680
Polovina	660	31	73/775	7,007	13	60/325	3,575	5,291
Polovina Cliffs	1,963	72	187/1800	18,895	56	151/1400	18,200	18,548
Little Polovina	714	25	71/625	6,285	15	45/375	5,950	6,118
Vostochni	4,311	157	517/3925	32,729	100	302/2500	35,687	34,208
Morjovi	2,217	52	185/1300	15,579	40	145/1000	15,290	15,434
Tolstoi	2,705	98	266/2450	24,914	106	283/2650	25,330	25,122
Lukanin	612	21	69/525	4,657	12	31/300	5,923	5,290
Kitovi	1,461	54	171/1350	11,534	34	111/850	11,188	11,361
Zapadni	2,982	130	439/3250	22,076	105	279/2625	28,056	25,066
Little Zapadni	1,647	82	261/2050	12,936	75	197/1875	15,676	14,306
Zapadni Reef	661	18	57/450	5,218	17	53/425	5,300	5,259
Total	25,868	954	--------	208,468	737	--------	220,821	214,644

Table 17.--Estimates of the pup population based on marked-to-unmarked ratios obtained by sampling groups of 100 after shearing, year class 1965, St. Paul Island

Rookery	Pups sheared	Samples of 100 pups	Sheared to total pups sampled	Estimated pup population at time of shearing
	Number	Number	Ratio	Number
Gorbatch	2,060	11	117/1100	19,368
Reef	3,559	17	162/1700	37,348
Ardiguen	316	2	42/200	1,505
Polovina	660	6	85/600	4,659
Polovina Cliffs	1,963	12	135/1200	17,449
Little Polovina	714	7	57/700	8,768
Vostochni	4,311	24	268/2400	38,606
Morjovi	2,217	21	260/2100	[1] 17,907
Tolstoi	2,705	16	143/1600	30,266
Lukanin	612	4	48/400	5,100
Kitovi	1,461	8	90/800	12,987
Zapadni	2,982	13	125/1300	31,013
Little Zapadni	1,647	9	86/900	17,236
Zapadni Reef	661	4	46/400	5,748
Total	25,868	154	----------	247,960

[1] Estimate for Morjovi, excluding south point of rookery is 17,034.

Table 18.--A comparison of counts and estimates of the pup population on four rookeries, year class 1965, St. Paul Island

Rookery	Total count	Pups estimated from:							
		First sample[1]		Second sample[2]		Third sample[3]		Mean of three samples	
		Number	Percent of count	Number	Percent of count	Number	Percent of count	Number	Percent of count
Kitovi Amphitheatre	1,248	1,403	112.4	911	73.0	1,360	109.0	1,225	98.2
Little Polovina	7,314	6,285	85.9	5,950	81.4	8,768	119.9	7,001	95.7
Morjovi[4]	18,384	14,714	80.0	14,434	78.5	17,034	92.7	15,874	86.3
Zapadni Reef	5,383	5,218	96.9	5,300	98.4	5,748	106.8	5,422	100.7
Total	32,329	27,620	85.4	26,595	82.3	32,910	101.8	29,522	91.3

[1] Based on samples of 25 pups, 3-4 August.
[2] Based on samples of 25 pups, 12-13 August.
[3] Based on samples of 100 pups, 2-11 August.
[4] Excluding point south of Sea Lion Neck.

Table 19.--Estimates of the pup population based on marked-to-unmarked ratios obtained by sampling live pups after shearing, year class 1965, St. Paul Island

Rookery	Pups estimated from:			Mean of three samples
	First sample[1]	Second sample[2]	Third sample[3]	
	Number	Number	Number	Number
Gorbatch	15,976	17,882	19,368	17,742
Reef	28,687	29,378	37,348	31,804
Ardiguen	1,975	3,386	1,505	2,289
Polovina	7,007	3,575	4,659	5,080
Polovina Cliffs	18,895	18,200	17,449	18,181
Little Polovina	6,285	5,950	8,768	7,001
Vostochni	32,729	35,687	38,606	35,674
Morjovi	15,579	15,290	17,907	16,258
Tolstoi	24,914	25,330	30,266	26,837
Lukanin	4,657	5,923	5,100	5,227
Kitovi	11,534	11,188	12,987	11,903
Zapadni	22,076	28,056	31,013	27,048
Little Zapadni	12,936	15,676	17,236	15,283
Zapadni Reef	5,218	5,300	5,748	5,422
Total	208,468	220,821	247,960	225,749

[1] Based on samples of 25 pups, 3-4 August.
[2] Based on samples of 25 pups, 12-13 August.
[3] Based on samples of 100 pups, 2-11 August.

St. Paul Island at the time of shearing in 1965. The uncorrected estimates for year classes 1961-65 for St. Paul Island are given in table 20.

An estimate of the total number of pups born on both Islands may be obtained by adding 247,500 to 30,000 (estimated mortality prior to the time of shearing), and extending the result (277,500) by dividing by 0.8, the proportion of Pribilof Islands harem bulls counted on St. Paul Island. This calculation gives 347,000 as the total number of pups born on both Islands in 1965.

Discussion of population estimates.--The number of pups born, as estimated from tag recoveries, has been decreasing steadily since 1959. Estimates based on tag recoveries, however, are about 150,000 higher than the estimates based on marking and sampling of live pups in the year of birth. The variability in the estimates based on tag recoveries by 5-day periods was not excessive for 3-year-old males but was considerable for 4-year-old males. In recent years estimates based on tag recoveries have shown less year-to-year variability than in the mid-1950's. Apparently, the factors that caused the highly variable and inflated estimates of the middle-1950's (Roppel, Johnson, and Chapman, 1965) are being eliminated.

There is some year-to-year variability in the number of pups born, as estimated from marking and sampling of live pups in the year of birth, but little variability within a year. The accuracy of the estimates, as checked by comparison with total counts, is satisfactory. Generally, the estimates are probably slightly low even though corrected for the difference between counts and estimates. This bias comes from the disproportionately large representation of small areas where total counts of live pups are made. The total estimate of 347,000 born in 1965 may, therefore, be slightly low.

The estimated number of yearling males for the 1961 and 1962 year classes are of the same general magnitude and fit reasonably well with other data.

Table 20.--Estimates[1] of the pup population at the time[2] of shearing or tagging, from marked-to-unmarked ratios, year classes 1961-65, St. Paul Island

Rookery	Year classes				
	1961[3]	1962[3]	1963[4]	1964[4]	1965[4]
	Number	Number	Number	Number	Number
Reef, Gorbatch, Ardiguen	85,700	52,800	55,600	65,100	51,800
Polovina, Polovina Cliffs	21,600	22,900	23,800	27,400	23,300
Little Polovina	7,500	7,200	6,500	8,400	7,000
Vostochni, Morjovi	47,400	36,700	52,000	59,800	51,900
Tolstoi	34,800	19,300	23,600	25,400	26,800
Little Zapadni	18,900	19,200	20,000	17,100	15,300
Zapadni, Zapadni Reef	38,000	33,600	32,400	39,900	32,500
Lukanin, Kitovi	22,100	11,900	16,000	19,200	17,100
Total	276,000	203,600	229,900	262,300	225,700

[1] The estimates for some rookeries have been combined so that the estimates for each year are comparable.
[2] Estimates do not include pups that died before shearing or tagging.
[3] Pups marked by tagging.
[4] Pups marked by shearing.

REPRODUCTION

The testes of 250 seals were collected on St. Paul Island in June and July incidental to a study of the age composition and territorial behavior of harem bulls. Tissue sections have been cut and stained with periodic acid Schiff's reagent. Variation in diameter of seminiferous tubules and in abundance of sperm are being studied. No investigation of spermatogenesis in the fur seal has been made in the Bureau's Marine Mammal Biological Laboratory, though Kenyon, Scheffer, and Chapman (1954) reported on the age of males at sexual maturity and the potency rate among adults. Their information was obtained from collaborators.

The genital tracts from 65 3-year-old and 51 4-year-old females taken in the kill 23-27 August on St. Paul Island were collected and preserved for later study. None of the 3-year-old females had given birth; one 4-year-old was primiparous and recently post partum. This sample is not necessarily representative of all 3- and 4-year-old females.

Thirty-one females were marked prior to, or just after, copulation or parturition and were killed at various dates thereafter. Physiological changes in their ovaries will be studied as an aid in interpreting the reproductive condition of females sampled from the kill.

OTHER STUDIES

This section contains brief descriptions of experimental procedures or special studies not discussed in the foregoing sections. Subjects discussed include experimental skins, radionuclides in seal teeth, seal behavior, and rookery charts.

Experimental Skins

Skins of 517 females and 361 males were collected on St. Paul Island to complete a collection begun in 1963 for a study of the relation of sex and age to the commercial value of sealskins. Skins collected for experimental use since 1958 are listed in table 21. In addition, 25 skins from males and 25 from females were collected for a study of sealskin quality being conducted by the North Pacific Fur Seal Commission, and 8 skins from males and 7 from females were sent to Japan.

In conference with a fur processor, a procedure was developed for maintaining the identity of experimental skins throughout the involved steps of factory processing. By this method, the numbered plastic tube tag originally fastened to each fresh skin on the killing field is replaced at the factory by a perforated symbol applied to the cheek of the salted skin. Through

Table 21.--Sealskins collected for experimental use, St. Paul Island, 1958 and 1961-65

Year	Males		Females	
	Ages	Number	Ages	Number
	Years		Years	
1958.....	------	--------	2-10	248
1961.....	------	--------	2-5	117
1962.....	2-4	9	2-15	171
1963.....	3-6	142	3-6	120
1964.....	2-7	641	2-6	436
1965.....	4-8	361	2-24	517

1965, the tube tags were fastened with monel wire. The monel wire, however, reacted with processing chemicals to produce a localized greenish stain on the skin and make the guard hair difficult to remove. A nylon line will be used for attaching tags in the future.

Skin samples from the midback of 48 females were collected on St. Paul Island 9 November 1964 to augment a study of 17 samples described by Scheffer and Johnson (1963). As expected, molt was most advanced in the younger animals. Molt was ending or had ended in 10 seals age 3 and 4 and was in various stages near midmolt in 15 seals, age 10 and older.

Radionuclides in Seal Teeth

In 1964, evidence of a radioactive substance (strontium 90?) was found in the 1962-63 layer of root substance of two fur seal teeth (Roppel, Johnson, Anas, and Chapman, 1965). The right upper canine teeth from 24 seals born in 1957 but killed in different years (2 males and 2 females at each of ages 1-6) were sectioned in 1965 and placed on Kodak[2] Nuclear Track Plates, Type NTB2, 25 Microns, for 133 days. All specimens had been taken at sea between California and Alaska. The results were negative; autoradiographs did not appear on the developed plates.

Seal Behavior

Richard S. Peterson studied the behavior of fur seals on St. Paul Island, mainly from an observation hut on Kitovi Rookery, during the summers of 1961-63. His findings were reported in a doctoral thesis (Peterson, 1965), one page of which is reproduced as figure 14 of this report.

Rookery Charts

Photocopies of 13 charts of the Pribilof rookeries as they appeared in the summer of

[2]Trade names referred to in this publication do not imply endorsement of commercial products.

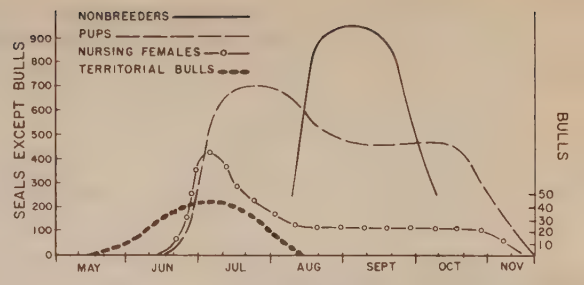


Figure 14.--Counts of territorial bulls, nursing females, pups, and nonbreeders, average of 3 years, Kitovi Rookery study area, St. Paul Island, 1961-63 (after Peterson, 1965).

1897 were obtained from the National Archives. The charts, which were based on a survey by the Will Ward Duffield party, were published in May-June 1898 as Coast and Geodetic Survey Nos. 3215 to 3228 (except No. 3224, which is a chart of St. George Island). Upon the photocopies will be entered the location of tripods, catwalks, numbered rocks, camera stations, and study plots (such as the plots for counting dead pups).

We plan to photograph the Pribilof rookeries from the air in mid-July 1967. The rookeries were last photographed from the air in 1958.

SUMMARY

Males

1. Of 41,268 male seals killed on the Pribilof Islands in 1965, 40,367 were taken during the kill of males from 7 July to 9 August and 901 were taken during the kill of females 16-27 August. St. Paul Island supplied 34,112 seals and St. George Island, 7,156. Age classification of 33,632 males killed on St. Paul Island was: age 2, 4 percent; age 3, 56 percent; age 4, 36 percent; and age 5, 4 percent. Age classification of 6,735 males killed on St. George Island was: age 2, 2 percent; age 3, 56 percent; age 4, 38 percent; age 5, 3 percent; and age 6; 1 percent. Age was not determined for 901 males killed on the Pribilof Islands. Most of the male seals killed were from 42 inches long (tip of nose to tip of tail) up to, but not including, those having a mane. The peak of the kill occurred 27-31 July when 6,032 males were taken on St. Paul Island. The minimum length was removed 22-26 July so that all available 2-year-old males could be killed. The abundance of 2-year-old males on land in late July may be related to return of the year class the following year at age 3. A total of 854 males older than those normally taken were killed for testing the commercial value of their skins.

2. The predicted kill of males on St. Paul Island in 1965 included 33,000 of age 3 and

16,000 of age 4; actual kills to 9 August were 19,009 and 12,046, respectively. The predicted kill of males on St. Paul Island in 1966 includes 3,000 of ages 2 and 5, 26,000 of age 3, and 14,000 of age 4.

3. Harem and idle bulls counted 10-18 July were 8,553 and 5,616 on St. Paul Island, and 1,917 and 1,113 on St. George Island.

Females

1. A total of 10,432 females were taken from the hauling grounds of the Pribilof Islands in 1965--3,868 during the kill of males 7 July to 9 August and 6,564 during the kill of females 16-27 August. St. Paul Island contributed 7,530, and St. George Island, 2,902. Selective killing for young females on St. Paul Island 23-27 August produced 3,435 (88 percent) in ages 2-5 and 456 age 6 and older. Nonselective killing for young females on St. George Island 16-27 August produced 1,708 (64 percent) in ages 2-5 and 965 age 6 and older.

2. Of 65 3-year-old females examined, none had given birth; 1 of 51 4-year-old females was primiparous and recently postpartum.

Tag Recoveries and Tagging

1. The kill in 1965 included 3,199 seals tagged as pups and 1,748 with checkmarks only. In addition, 36 Soviet-tagged seals were taken, and 238 seals selected and tagged as yearlings in previous years were recovered.

2. Ten thousand pups were tagged on the left front flipper with an R-series tag, and a V-notch checkmark was cut into the leading edge of the same flipper near the tip. In addition, 10,080 pups were marked only by removing the tip of the first digit (big toe) of the right hind flipper, and 10,007 were marked only by cutting a V-notch into the leading edge of the right front flipper near the tip.

3. A total of 922 seals selected as yearlings on the basis of body length were double-tagged, one tag (1R-series) to each front flipper; 69 yearlings tagged as pups in 1964 were recaptured in 1965 and given an additional tag.

Pup Mortality

Counts of dead pups in late August were 41,080 on St. Paul Island and 5,228 on St. George Island.

Pup Weights

Weights of 1,193 pups showed that untagged and unmarked males and females weighed 1.14 and 1.04 kg. more than tagged and marked males and females in 1965. Six hundred pups that were marked only weighed less than untagged and unmarked pups but more than tagged and marked pups.

Population Estimates

1. On the basis of tag recoveries from males and the number of dead pups counted on the rookeries, 560,000 pups were born on the Pribilof Islands in 1961 and 500,000 in 1962.

2. Including estimated mortality before shearing, marked-to-unmarked ratios obtained from shearing and sampling pups yielded an estimate of 347,000 pups born on the Pribilof Islands in 1965.

3. Estimates of the pup population for different year classes, based on tag recoveries from females, were: year class 1960--344, 107; 1961--527, 482; and 1962--337,012.

4. On the basis of recoveries of seals tagged as yearlings, yearling males were estimated at 78,000 in 1961 and 85,000 in 1962.

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GLOSSARY

The following terms used in fur seal research and management on the Pribilof Islands have special meanings or are not readily found in standard dictionaries.

Age Class. Age Group. Seals of the same age (usually used when referring to seals older than pups). See year class.

At Time of Tagging (or Sampling) Phrases used to qualify estimates of the population based on (1) tag returns at various ages or (2) sampling for a marked-to-unmarked ratio in the summer of birth. In either situation, an estimate of the total number of pups born in a given year would include pups alive "at time of tagging" (or "sampling") plus the number that died before tagging or sampling.

Checkmark A notch, slit, hole, or other mark made on a seal flipper when a tag is applied, to ensure later recognition of an animal that has lost its tag. See marked, lost tag, and tag-scar.

Clinch or Clinching The device or action by which metal tags applied to seal flippers are fastened. A metal point is inserted through an opening in the opposite end of the metal strip, then bent over a narrow band to form a closed ring (or tag).

Drive The act of surrounding and moving groups of seals on land from one location to another.

Escapement Seals that were not killed because they were either too old, too large, or were not available.

Female Kill That part of the annual harvest devoted principally to the kill of female seals, usually in August. See male kill.

General Breeding Season Organized breeding beginning about mid-June and ending in early August. Identifiable by the formation of harems. A limited amount of breeding also occurs after the breakup of the harem structure.

Hauling Ground An area, usually near a rookery, on which nonbreeding seals congregate. See rookery.

Haul Out The act of seals moving from the sea to a rookery or hauling ground on shore.

Homing Tendency The inclination of seals to return to the rookery where they were born--that is, home rookery or rookery of birth. Homing tendency is expressed as a percentage by comparing the number of tagged seals in a specific group that were found on their natal rookery with the number that were found on some other rookery or island.

Known-age Applied to seals for which age is definitely known because they bear an inscribed tag or have a certain combination of tag-scar and checkmark.

Lost-tag A term applied to a seal that is known to have been tagged because of a checkmark and, in some, a healed tag scar. See tag-scar.

Lost-tag-to-tag Ratio The number of seals that have lost tags as compared with the number retaining tags. Usually expressed as a decimal fraction.

Male Kill That part of the annual harvest devoted principally to the kill of male seals, usually in late June, in July, and in early August. See female kill.

Mane A secondary sex characteristic composed of long, silver-colored guard hairs on the shoulders and on back of the neck. The mane appears on some males at age 5, on most at age 6, and on all at age 7 and older.

Marked Seals that have been tagged or sheared so that they can be identified. Removal of a hind flipper digit, cutting a V-notch in the leading edge of a front flipper near the tip, or slicing off the tip of a front flipper are also examples of marking. These marks, when applied to seals in conjunction with tags, are considered checkmarks. When applied alone, they are considered as marks only. See checkmark, lost-tag, and tag-scar.

Marked-to-unmarked Ratio The number of marked seals compared with the number of unmarked seals, usually expressed as a decimal fraction. Example, 5:20, ratio 0.25.

Mixed Areas Areas behind some of the rookeries on which few seals appear until August, or after the general breeding season. Seals using these areas at that time may be a mixture of animals from traditional hauling grounds and from the rookery.

Mortality Percentage of a year class dying during a specific period.

Pregnancy Rate Percentage of females that were carrying or had borne pups in the year of examination. For example, the pregnancy rate of 5-year-old females was 40 percent.

Return The return or survival of seals from a year class. For example, 18,642 3-year-old seals from the 1960 year class returned in 1963.

Rookery An area on which breeding seals congregate.

Round The sequence in which hauling grounds on St. Paul Island are visited to collect seals for harvest. Current practice is to make a complete circuit or round of the hauling grounds in 5 days and to repeat the procedure throughout the kill of males. The round system is not followed during the kill of females on St. Paul Island, nor during the kill of males and females on St. George Island.

Round-up The act of surrounding and collecting seals to be driven for harvest, tagging, or other purposes.

Tagged Describes a seal having an inscribed metal tag or tags attached to one or more of its flippers.

Tag Recoveries Includes tags recovered and seals identified from checkmarks or tag scars as having lost their tags. See checkmark, marked, lost-tag, and tag-scar.

Tar-scar A hole or torn area near the usual tag site on a seal's flipper. Tags fall out because of poor clinching or wear and are forcibly torn out by catching in rock crevices or driftwood. Possibly some are torn out by the tagged seal.

Tagged-to-Untagged Ratio See marked-to-unmarked ratio.

Year Class Group of seals born in the same year. See age class.

APPENDIX A

PREDICTIONS OF 1966 KILL OF MALES

Douglas G. Chapman

18 November 1965

Prediction of 4-Year-Old Male Kill

Regression of kill of 4-year males on kill of 3-year males and the mean date of the kill at age 3.--Predictions of the kill at age 4 have been relatively easy and more accurate than predictions of the kill at age 3. This difference is to be expected, because the return at age 3 gives much information on the strength of the year class. Initially an estimate was made of the escapement of 3-year-old males from the kill which, in turn, provided an estimate of the return at age 4. Subsequently, I found that this estimate of the escapement was in fact a considerable underestimate. It seemed more reasonable, therefore, to estimate the returns at age 4 directly rather than through a fictitious escapement estimate. This approach was based on a regression where the independent (i.e., predictive) variables were (a) the number of 3-year-old males killed in July, and (b) the timing of the return as measured by the mean date of the kill of 3-year-olds in July. A sufficiently long series of comparable data is available only for the month of July, although substantial numbers of male seals were also killed in August in recent years. Adjustments have been made for extensions of the kill into August.

The regression for the returns of year classes 1952-61 is:

$$Y = -15.0 + 0.62X_1 + 5.07X_2$$

where

- Y = kill of 4-year-old males to 31 July plus 80 percent of the kill of 3-year-old males after 31 July of the previous year
- X_1 = kill of 3-year-old males to 31 July
- X_2 = mean date of the kill of 3-year-old males in July, as measured from 15 July

The coefficient of multiple correlation is 0.90 ($R^2 = 0.81$).

In recent years, not only has the kill been extended into August but the first day of the kill has also been advanced. Comparable data have been obtained only by adjusting to the basis of a 27 June starting date (the starting date during the middle 1950's). When the starting date was 2 July, it was necessary to prorate a portion of the 2-6 July kill that might have been taken 27 June to 1 July, if the kill had started at the earlier date.

In 1965, the kill began on 7 July, so that a further backward extrapolation became necessary to estimate X_2. It is not surprising, therefore, that the resulting estimate is not reasonable. For 1965, $X_1 = 12$, $X_2 = 6$, and $\hat{Y}$ is 30,000. The X_2 value of 6 is higher than any that occurred in the period from which the regression is computed.

Regression of percentage of the kill from a year class at ages 3 and 4 taken at age 3 on (a) date of termination, and (b) median date of the kill at age 3.--The data for this regression are given in appendix table 1.

An average of 67.4 percent (standard deviation 10.17) of the kill of males from a year class at ages 3 and 4 occurs at age 3. The 95-percent confidence interval for any individual observed percentage is:

$$67.4 \pm 2.16\left(1 + \frac{1}{15}\right)^{1/2}(10.17)$$

i.e., (44.7, 90.1).

At the lower confidence limit, the percentage of 44.7 means that the upper bound of the kill at ages 3 and 4 from the 1962 year class is 19,000÷0.447, or 43,000. This figure leaves 26,000 for the kill of 4-year-olds in 1966, which, although below the estimate from the regression based on the mean date, is still a high estimate.

The above estimate of 26,000 can be improved by calculating the regression of P_3 (percentage of kill at ages 3 and 4 taken at age 3) on the termination date (t) and either the median date (m) or the last round percentage (l). Either of the variables, median date or percentage in the last 5 days of July, measures to some degree the lateness of the returns. Perhaps the median date yields a better estimator than does the percentage in the last 5 days. The respective equations are:

$$P_3 = 74.7 + 0.39t - 0.40l \qquad R = 0.50$$

and

$$P_3 = 62.4 + 1.95t - 2.21m \qquad R = 0.64$$

where

- p_3 = percentage of the kill at ages 3 and 4 from a year class taken at age 3
- t = termination date (in days after 31 July)
- l = percentage of the 3-year-old males killed in last 5 days in July
- m = median date of the kill of 3-year-old males

Appendix table 1.--Data for the regression of percentage of the kill from a year class at ages 3 and 4 taken at age 3 on date of termination and median date of the kill at age 3, year classes 1947-61, St. Paul Island

Year class	Proportion of kill from a year class at ages 3 and 4 taken at age 3	Termination date of kill of 3-year-old males	Median date of kill of 3-year-old males	Proportion of kill at age 3 taken in last 5 days of July
	Percent			Percent
1947.....	56	27 July	13 July	20
1948.....	56	29 July	18 July	29
1949.....	71	27 July	15 July	24
1950.....	73	29 July	18 July	31
1951.....	64	27 July	17 July	32
1952.....	49	31 July	21 July	28
1953.....	81	15 Aug.	24 July	15
1954.....	81	10 Aug.	24 July	15
1955.....	75	31 July	17 July	16
1956.....	79	31 July	18 July	18
1957.....	61	7 Aug.	27 July	18
1958.....	77	15 Aug.	27 July	14
1959.....	65	5 Aug.	22 July	11
1960.....	58	5 Aug.	23 July	19
1961.....	65	5 Aug.	23 July	20

For the 1962 year class the median date of the kill of 3-year-old males is 27 July and the terminal date is 9 August. Thus, for the 1962 year class p_3 is estimated as 65.1 (in the actual equation the median date was estimated by interpolation to tenths of a day; for the 1962 year class, m=6.7). The kill at ages 3 and 4 from the 1962 year class is estimated as 29,200, i.e., 19÷0.651; hence the estimate of the kill of 4-year-old males is 10,200. The standard error of the estimated p_3 for the 1962 year class is 9.6. This value is equivalent to an error in the forecast total of about 4,500.

Regression of returns on air temperature.--Appendix table 2 shows the data for this regression, i.e., the mean temperature at St. Paul Island for the 12 months ending 30 June of the year of birth, and the total kill from the year class at ages 3 and 4. Use of the total kill at ages 3 and 4 represents a modification of the dependent variable previously used. Previously, the dependent variable was the kill of a year class prior to 31 July at ages 3 and 4 plus 80 percent of the kill of 3-year-olds in August. This "adjusted" kill was used to obtain comparable data from early years when the kill ended prior to 31 July and from recent years when the kill usually has been extended into August.

The adjustment, however, made it difficult to evaluate the error of this forecast. Moreover, the analysis given in the previous section shows that the terminal date plays a small role in the percentage taken at age 3 and presumably a still smaller role in the total kill from a year class.

Appendix table 2.--The kill of 3- and 4-year-old males and mean air temperature, year classes 1950-61, St. Paul Island

Year class	Temperature (degrees of Fahrenheit in tenths of a degree above 32) T	Kill at ages 3 and 4 Y
	Number	Number
1950.....	35	56,000
1951.....	36	50,000
1952.....	37	62,000
1953.....	16	47,000
1954.....	10	29,000
1955.....	17	38,000
1956.....	1	13,000
1957.....	23	40,000
1958.....	34	63,000
1959.....	33	41,000
1960.....	26	25,000
1961.....	18	35,000

The regression equation is:

$$Y = 16.6 + 1.05T \qquad r = 0.81$$

For the 1962 year class T=21 and hence:

$$\hat{Y} = 38.7$$

Since the kill of 3-year-old males in 1965 was 19,000, a balance of 19,700 for the kill of 4-year-old males in 1966 is implied.

By this method, the standard error of the predicted Y (kill of 3- and 4-year-old males) is 9,600. This is also the standard error of the forecast of the kill of 4-year-olds in 1966.

Estimated return based on estimates of yearling population.--As shown elsewhere in this report, the estimated number of yearling males in 1962 (from the 1961 year class), based on 352 recoveries to date, is 77,827, whereas the estimated number of yearling males in 1963 (from the 1962 year class) is 73,320 (180 recoveries). If possible bias in the latter estimate based on recoveries through age 3 is disregarded, and if mortality varies most during the first year of life, the returns from the 1962 year class should be 73,320÷77,827, or 94 percent of those from the 1961 year class. At the end of the kill in 1965, the St. Paul Island returns from the 1961 and 1962 year classes to date were:

Kill at age	Year class 1961	1962
2	1.1	2.5
3	22.5	19.0
4	12.0	-
Total	35.6	21.5

Ninety-four percent of 35,600 is 33,500, and, of this return, the number remaining is 12,000. The standard error of this estimate, which is difficult to measure, depends on the variability in survival after age 1, on which we have no information, together with the variability in the estimates of the yearling groups. The minimum error in the difference between the two groups is given by the formula:

$$\text{S. E. (Difference)} = \sqrt{\frac{N_1^2}{s_1} + \frac{N_2^2}{s_2}}$$

when N_1, N_2 are the respective population estimates and s_1, s_2 are the tag recoveries on which they are based. Hence, S.E. = 6,800.

The effect of this S.E. on the forecast of the kill of 4-year-old males in 1966 can be evaluated in the following way. The S.E. of 6,800 represents about 9 percent of the estimate of the yearling populations. A 9 percent error in the returns of the 1961 year class is 3,200 and this, then, is the lower limit of the S.E. of the forecast of the kill of 4-year-old males in 1966. In addition to ignoring variations in mortality after age 1, this standard error ignores any variability incurred because of errors in determining the ages of seals selected for tagging as yearlings or any possible clustering effects. To allow very roughly for these effects, a standard error of 4,000 is estimated.

Weighted Estimate on the Kill of 4-year-old Males.--From the foregoing methods, the three estimates regarded as valid and their standard errors are:

(1) From regression of percentage of kill at age 3 on termination date and median date:

Estimate 10,200 S.E. 4,500

(2) From temperature-return equation:

Estimate 19,700 S.E. 9,600

(3) From estimates of yearlings:

Estimate 12,400 S.E. 4,000

The weighted mean estimate is 12,300. The unweighted mean estimate is 14,100. In view of the uncertainty of the S.E. of the third estimate, and the fact that the estimate of yearlings of the 1962 year class may be somewhat low, it is perhaps best to use the unweighted mean estimate, 14,100.

Prediction of Kill of 3-Year-Old Males

Correlation of kill of 3-year-old males with return of 2-year-olds.--The prediction of this component of the kill is more difficult. As shown in appendix table 2, the kill from a year class at age 3 represents 67 percent of the kill at ages 3 and 4 and is by far the largest component. The number of 2-year-old males killed is extremely variable because most of them are below the acceptable length limits and because the timing of their return apparently varies. If substantial numbers of 2-year-olds return in early August, they will appear in the kill, but if their return is delayed by a few days the number of 2-year-olds killed is much smaller. For these and perhaps other reasons, as noted by Chapman (Roppel, Johnson, Anas, and Chapman, 1965), the correlation of the kill of 3-year-old males with the best present index of 2-year-old returns (kill in a late round) is extremely small (r^2=0.20). Such a regression essentially yields the long-term mean as the predicted value and, hence, particularly fails as a forecasting tool. A prediction is of value primarily if it can identify those years when deviations much above or much below the mean will occur.

The suggestion has been made that the proportions of tagged males in the kill have been directly related to the survival of the year class; this idea in turn has given rise to the thought that the proportion of tags among

2-year-olds might serve as a guide to year-class strength. The correlation is only 0.06, however; thus, this variable obviously has no value for forecasting.

Regression of Return on Temperature.--This estimated regression was calculated above as:

$$Y = 16.6 + 1.05T$$

where

Y = the kill of males at ages 3 and 4
T = mean temperature

For the 1963 year class T = 28 (2.8° above 32°), to give Y = 46,000, the kill at ages 3 and 4. At the present time, the best estimate of the number that might be taken at age 3 is (0.67)(46,000) = 31,000.

The standard error of the forecast Y (kill at ages 3 and 4) is 10,000. In addition, the percentage taken at age 3 varies (standard error of the percentage is 10.17). Because of this variability, a standard deviation of 8,500 in the forecast of the kill of 3-year-old males in 1966 is calculated. The count of dead pups was also tried as a variable in this regression. Chapman (Roppel, Johnson, and Chapman, 1965) found, however, that the count of dead pups yields essentially the same information as the temperature variable and thus does not provide an additional basis for forecasting. Data for 2 additional years do not change this conclusion.

Regression of Return on Pup Weights in Autumn.--Pups were weighed in autumn to measure the relation of weight to survival. The data for this regression are shown in appendix table 3.

The regression equation is:

$$K = 9.7w - 66.65 \qquad (r = 0.81)$$

where

K = kill in thousands at age 3
w = mean weight of untagged males

The rather high correlation is due primarily to one point, that of the 1958 year class. The forecast for the 1963 year class is 19,700 (w = 8.9). The standard error is 8,700. In weighting this estimate with the estimate from the temperature-return regression, however, I have to allow for the fact that this regression is based on a much shorter series (4 degrees of freedom compared with 10). When this adjustment is made, the weights of the two estimates are 0.60 (temperature) and 0.40 (mean pup weights). The weighted average of the two forecasts is 26,400.

Prediction of Total Kill

As in previous years, the estimates for St. Paul Island are extrapolated to St. George Island by the long-term proportion of 0.20 for the latter. In 1963 and 1964, the kill of males on St. George Island was in excess of 20 percent of the kill on both islands, but in 1965 it fell to 17.3. The cause of variations between the two islands is difficult to determine. The predicted kill of male seals on the Pribilof Islands in 1966 is given in appendix table 4.

The forecasted and actual kills of males are compared in appendix table 5 for 1961-65.

Appendix table 3.--Mean weight of untagged male pups and kill of 3-year-old males from the year class, St. Paul Island, 1957-62

Year class	Mean weight	Kill
	Kg.	Number
1957.....	8.7	24,000
1958.....	11.4	48,000
1959.....	9.4	26,000
1960.....	9.8	14,000
1961.....	8.5	22,000
1962.....	9.2	19,000

Appendix table 4.--Predictions of the kill of males in 1966, by age, Pribilof Islands, Alaska

Island	Age in years			Predicted kill
	2 and 5	3	4	
	Number	Number	Number	Number
St. Paul...	3,000	26,000	14,000	43,000
St. George.	1,000	7,000	3,000	11,000
Total....	4,000	33,000	17,000	54,000

Appendix table 5.--Comparison of forecasted and actual kills of males, 1961-65

Ages	Forecasted kill	Actual kill to end of regular season
Years	Number	Number
	1965 (Pribilof Islands)	
2 + 5	4,000	2,851
3	33,000	22,767
4	16,000	14,641
Total	53,000	40,259
	1964 (Pribilof Islands)	
2 + 5	3,800	4,978
3	30,000	28,827
4	16,200	13,073
Total	50,000	46,878
	1963 (Pribilof Islands)	
2 + 5	3,800	3,217
3	50,000	17,986
4	18,800	18,394
Total	72,600	39,597
	1962 (St. Paul Island only)	
2 + 5	3,000	1,463
3	36,000	25,098
4	11,000	13,422
Total	50,000	39,983
	1961 (St. Paul Island only)	
3	20,000	29,523
4	20,000	12,488
Total	40,000	42,011

APPENDIX B

Appendix table 6.--Age classification of male seals killed on St. Paul Island, 7 July to 9 August 1965

Date	Rookery[1]	Number		Percent in each age class of sample					Estimated number killed from each age class				
		Males kills[2]	Tooth sample	2	3	4	5	6	2	3	4	5	6
July:													
7.....	NEP.....	920	185	1	39	56	4	------	9	359	515	37	-------
8.....	TZR.....	451	135	1	38	56	4	1	5	171	252	18	5
9.....	ZAP.....	1,020	103	1	34	61	4	------	10	347	622	41	-------
10.....	REEF-LK.....	778	163	------	31	62	6	1	-----	241	482	47	8
11.....	POL.....	314	65	------	35	57	6	2	-----	110	179	19	6
Round total	.....	3,483	651						24	1,228	2,050	162	19
July:													
12.....	NEP.....	829	83	------	48	46	6	------	-----	398	381	50	-------
13.....	TZR.....	314	66	------	38	49	2	1	-----	120	185	6	3
13.....	REEF.....	138	24	4	50	46	-----	------	6	69	63	-----	-------
14.....	ZAP.....	954	95	2	37	56	5	------	19	353	534	48	-------
15.....	REEF.....	725	73	1	41	50	7	1	7	297	363	51	7
15.....	LK.....	149	29	------	52	48	-----	------	-----	77	72	-----	-------
16.....	POL.....	212	42	2	45	38	10	5	4	95	81	21	11
Round total	.....	3,321	412						36	1,409	1,679	176	21
July:													
17.....	NEP.....	1,758	169	3	55	38	4	-----	53	967	668	70	-------
18.....	TZR.....	253	51	------	33	53	10	4	------	84	134	25	10
18.....	LK.....	110	22	------	40	50	5	5	------	44	56	5	5
19.....	ZAP.....	1,718	173	1	53	42	4	-----	17	911	721	69	-------
20.....	REEF.....	809	151	3	49	42	5	1	24	397	340	40	8
20.....	LK.....	87	23	------	48	52	-----	-----	------	42	45	-----	-------
21.....	POL.....	367	71	------	42	49	9	-----	------	154	180	33	-------
Round total	.....	5,102	660						94	2,599	2,144	242	23
July:													
22.....	NEP.....	1,645	320	5	57	36	2	-----	82	938	592	33	-------
23.....	TZR.....	538	105	3	49	39	9	-----	16	264	210	48	-------
23.....	LK.....	137	25	-----	68	28	4	-----	-----	93	39	5	-------
24.....	ZAP.....	1,696	337	5	56	37	2	-----	85	950	627	34	-------
25.....	REEF.....	1,009	200	4	63	31	2	-----	40	636	313	20	-------
25.....	LK.....	161	32	9	60	28	3	-----	14	97	45	5	-------
26.....	POL.....	427	86	2	52	43	3	-----	8	222	184	13	-------
Round total	.....	5,613	1,105						245	3,200	2,010	158	-------
July:													
27.....	NEP.....	2,276	415	4	70	24	2	-----	91	1,593	546	46	-------
28.....	TZR-LK.....	574	100	1	48	45	5	1	6	275	258	29	6
29.....	ZAP.....	1,668	326	1	59	37	3	-----	17	984	617	50	-------
30.....	REEF-LK.....	1,003	200	4	55	37	4	-----	40	552	371	40	-------
31.....	POL.....	511	97	6	56	32	6	-----	31	286	163	31	-------
Round total	.....	6,032	1,138						185	3,690	1,955	196	6
Aug.:													
1.....	NEP.....	1,195	269	6	69	23	2	-----	72	824	275	24	-------
2.....	TZR.....	472	104	4	56	35	5	-----	19	264	165	24	-------
3.....	ZAP.....	1,297	279	3	65	28	4	-----	39	843	363	52	-------
4.....	REEF-LK.....	979	228	5	61	30	4	-----	49	597	294	39	-------
5.....	POL.....	405	93	1	62	29	7	1	4	251	118	28	4
5.....	ZAP-REEF....	443	94	7	77	14	2	-----	31	341	62	9	-------
Round total	.....	4,791	1,067						214	3,120	1,277	176	4
Aug.:													
6.....	NEP.....	2,161	598	10	74	13	3	-----	216	1,599	281	65	-------
7.....	TZR.....	981	218	5	72	21	2	-----	49	706	206	20	-------
8.....	REEF.....	811	224	5	61	30	4	-----	41	495	243	32	-------
9.....	NEP.....	1,337	368	12	72	15	1	-----	160	963	201	13	-------
Round total	.....	5,290	1,408						466	3,763	931	130	-------
Season total	.....	[3]34,112	6,441						1,264	19,009	12,046	1,240	73

[1] NEP = Northeast Point (Vostochni and Morjovi rookeries); TZR = Tolstoi, Zapadni Reef, Little Zapadni; ZAP = Zapadni; REEF-LK = Reef, Gorbatch, Ardiguen, and Lukanin, Kitovi; POL = Polovina, Polovina Cliffs, Little Polovina.

[2] Includes experimental and rejected skins.

[3] Includes 480 unclassified males taken during the female kill, 23-27 August. Does not include 854 males in ages 4-8 taken for special purposes.

Appendix table 7.--Cumulative age classification of male seals killed on St. Paul Island, 7 July to 9 August 1965

Date	Rookery[1]	Estimated number killed from each age class[2]					Total kill	Percent killed from each age class				
		2	3	4	5	6		2	3	4	5	6
July:												
7.....	NEP.....	9	359	515	37	------	920	1	39	56	4	---
8.....	TZR.....	14	530	767	55	5	1,371	1	39	56	4	---
9.....	ZAP.....	24	877	1,389	96	5	2,391	1	37	58	4	---
10.....	REEF-LK....	24	1,118	1,871	143	13	3,169	1	35	59	5	---
11.....	POL.....	24	1,228	2,050	162	19	3,483	1	35	59	5	---
12.....	NEP.....	24	1,626	2,431	212	19	4,312	1	38	56	5	---
13.....	TZR.....	24	1,746	2,616	218	22	4,626	1	38	56	5	---
13.....	REEF.....	30	1,815	2,679	218	22	4,764	1	38	57	4	---
14.....	ZAP.....	49	2,168	3,213	266	22	5,718	1	38	56	5	---
15.....	REEF.....	56	2,465	3,576	317	29	6,443	1	38	56	5	---
15.....	LK.....	56	2,542	3,648	317	29	6,592	1	39	55	5	---
16.....	POL.....	60	2,637	3,729	338	40	6,804	1	39	55	5	---
17.....	NEP.....	113	3,604	4,397	408	40	8,562	1	42	52	5	---
18.....	TZR.....	113	3,688	4,531	433	50	8,815	1	42	51	5	1
18.....	LK.....	113	3,732	4,587	438	55	8,925	1	42	51	5	1
19.....	ZAP.....	130	4,643	5,308	507	55	10,643	1	44	50	5	---
20.....	REEF.....	154	5,040	5,648	547	63	11,452	1	44	50	5	---
20.....	LK.....	154	5,082	5,693	547	63	11,539	1	44	50	5	---
21.....	POL.....	154	5,236	5,873	580	63	11,906	1	44	50	5	---
22.....	NEP.....	236	6,174	6,465	613	63	13,551	2	45	48	5	---
23.....	TZR.....	252	6,438	6,675	661	63	14,089	2	46	47	5	---
23.....	LK.....	252	6,531	6,714	666	63	14,226	2	46	47	5	---
24.....	ZAP.....	337	7,481	7,341	700	63	15,922	2	47	46	5	---
25.....	REEF.....	377	8,117	7,654	720	63	16,931	2	48	46	4	---
25.....	LK.....	391	8,214	7,699	725	63	17,092	2	48	45	5	---
26.....	POL.....	399	8,436	7,883	738	63	17,519	2	48	45	5	---
27.....	NEP.....	490	10,029	8,429	784	63	19,795	2	51	43	4	---
28.....	TZR-LK.....	496	10,304	8,687	813	69	20,369	2	51	43	4	---
29.....	ZAP.....	513	11,288	9,304	863	69	22,037	2	51	43	4	---
30.....	REEF-LK....	553	11,840	9,675	903	69	23,040	2	52	42	4	---
31.....	POL.....	584	12,126	9,838	934	69	23,551	2	52	42	4	---
Aug.:												
1.....	NEP.....	656	12,950	10,113	958	69	24,746	3	52	41	4	---
2.....	TZR.....	675	13,214	10,278	982	69	25,218	3	52	41	4	---
3.....	ZAP.....	714	14,057	10,641	1,034	69	26,515	3	53	40	4	---
4.....	REEF-LK....	763	14,654	10,935	1,073	69	27,494	3	53	40	4	---
5.....	POL.....	767	14,905	11,053	1,101	73	27,899	3	53	40	4	---
5.....	ZAP-REEF...	798	15,246	11,115	1,110	73	28,342	3	54	39	4	---
6.....	NEP.....	1,014	16,845	11,396	1,175	73	30,503	3	55	38	4	---
7.....	TZR.....	1,063	17,551	11,602	1,195	73	31,484	3	56	37	4	---
8.....	REEF.....	1,104	18,046	11,845	1,227	73	32,295	3	56	37	4	---
9.....	NEP.....	1,264	19,009	12,046	1,240	73	[3] 33,632	4	56	36	4	---

[1] NEP = Northeast Point (Vostochni and Morjovi rookeries); TZR = Tolstoi, Zapadni Reef, Little Zapadni; ZAP = Zapadni; REEF-LK = Reef, Gorbatch, Ardiguen, and Lukanin, Kitovi; POL = Polovina, Polovina Cliffs, Little Polovina.

[2] Includes experimental and rejected skins.

[3] Does not include 854 males in ages 4-8 taken for special purposes, nor 480 unclassified males taken during the female kill, 23-27 August.

Appendix table 8.--Age classification of male seals killed on St. George Island, 7 July to 6 August 1965

Date	Rookery[1]	Number		Percent in each age class of sample					Estimated number killed from each age class				
		Males killed	Tooth sample	2	3	4	5	6	2	3	4	5	6
July:													
7...	NOR.....	288	29	-------	21	72	7	------	------	61	207	20	-------
7...	EAST....	333	34	-------	44	47	9	------	------	146	157	30	-------
9...	ZAP.....	314	31	-------	45	55	-------	------	------	141	173	-------	-------
12..	NOR.....	102	22	-------	41	50	9	------	------	42	51	9	-------
12..	EAST....	222	42	2	48	41	2	7	4	107	91	4	16
14..	NOR.....	47	15	-------	47	47	6	------	------	22	22	3	-------
14..	ZAP.....	121	37	-------	27	65	5	3	------	33	79	6	3
16..	EAST....	326	31	-------	39	61	-------	------	------	127	199	-------	-------
16..	NOR.....	288	30	-------	57	40	3	------	------	164	115	9	-------
19..	ZAP.....	174	17	-------	18	58	6	18	------	31	101	11	31
19..	STAR....	96	26	-------	58	34	4	4	------	56	32	4	4
19..	NOR.....	64	18	-------	50	44	-------	6	------	32	28	-------	4
21..	EAST....	279	56	5	43	50	2	------	14	120	140	5	-------
21..	NOR.....	184	36	-------	56	44	-------	------	------	103	81	-------	-------
23..	NOR.....	311	31	3	64	33	-------	------	9	199	103	-------	-------
23..	ZAP.....	154	31	-------	42	55	-------	3	------	65	85	-------	4
26..	EAST....	591	59	5	64	31	-------	------	30	378	183	-------	-------
28..	ZAP.....	174	51	-------	55	35	10	------	------	96	61	17	-------
28..	NOR.....	817	80	8	66	21	5	------	65	539	172	41	-------
30..	EAST....	290	55	2	56	40	2	------	6	162	116	6	-------
Aug.:													
2...	ZAP.....	239	47	-------	62	36	2	------	------	148	86	5	-------
2...	NOR.....	202	42	-------	79	21	-------	------	------	160	42	-------	-------
4...	STAR....	140	65	2	58	34	6	------	3	81	48	8	-------
4...	EAST....	305	30	3	67	30	-------	------	9	204	92	-------	-------
6...	NOR.....	674	74	4	77	19	-------	------	27	519	128	-------	-------
Season total.		[2] 7,156	989						167	3,736	2,592	178	62

[1] NOR = North; EAST = East Reef, East Cliffs; ZAP = Zapadni, South; STAR = Staraya Artil.
[2] Includes 421 unclassified males taken during the female kill, 16-27 August.

Appendix table 9.--Cumulative age classification of male seals killed on St. George Island, 7 July to August 1965

Date	Rookery[1]	Estimated number killed from each age class					Total kill	Percent killed from each age class				
		2	3	4	5	6		2	3	4	5	6
July:												
7...	NOR.....	-------	61	207	20	-------	288	-------	21	72	7	-------
7...	EAST....	-------	207	364	50	-------	621	-------	33	59	8	-------
9...	ZAP.....	-------	348	537	50	-------	935	-------	37	58	5	-------
12..	NOR.....	-------	390	588	59	-------	1,037	-------	38	57	5	-------
12..	EAST....	4	497	679	63	16	1,259	-------	40	54	5	1
14..	NOR.....	4	519	701	66	16	1,306	-------	40	54	5	1
14..	ZAP.....	4	552	780	72	19	1,427	-------	39	55	5	1
16..	EAST....	4	679	979	72	19	1,753	-------	39	56	4	1
16..	NOR.....	4	843	1,094	81	19	2,041	-------	41	54	4	1
19..	ZAP.....	4	874	1,195	92	50	2,215	-------	40	54	4	2
19..	STAR....	4	930	1,227	96	54	2,311	-------	41	53	4	2
19..	NOR.....	4	962	1,255	96	58	2,375	-------	41	53	4	2
21..	EAST....	18	1,082	1,395	101	58	2,654	-------	41	53	4	2
21..	NOR.....	18	1,185	1,476	101	58	2,838	1	42	52	3	2
23..	NOR.....	27	1,384	1,579	101	58	3,149	1	44	50	3	2
23..	ZAP.....	27	1,449	1,664	101	62	3,303	1	44	50	3	2
26..	EAST....	57	1,827	1,847	101	62	3,894	1	47	47	3	2
28..	ZAP.....	57	1,923	1,908	118	62	4,068	1	47	47	3	2
28..	NOR.....	122	2,462	2,080	159	62	4,885	3	50	43	3	1
30..	EAST....	128	2,624	2,196	165	62	5,175	3	51	42	3	1
Aug.:												
2...	ZAP.....	128	2,772	2,282	170	62	5,414	3	51	42	3	1
2...	NOR.....	128	2,932	2,324	170	62	5,616	2	52	42	3	1
4...	STAR....	131	3,013	2,372	178	62	5,756	2	53	41	3	1
4...	EAST....	140	3,217	2,464	178	62	6,061	2	53	41	3	1
6...	NOR.....	167	3,736	2,592	178	62	[2] 6,735	2	56	38	3	1

[1] NOR = North; EAST = East Reef, East Cliffs; ZAP = Zapadni, South; STAR = Staraya Artil.
[2] Does not include 421 unclassified males taken during the female kill, 16-27 August.

Appendix table 10.--Counts of harem and idle bulls, by rookery, Pribilof Islands, Alaska, 1965

Date	Rookery	Bulls		Total
		Harem	Idle	
	St. Paul Island			
July:				
10.....	Gorbatch.....	674	520	1,194
	Ardiguen.....	105	69	174
	Reef.....	1,179	670	1,849
	Total.....	1,958	1,259	3,217
11.....	Polovina.....	220	406	626
	Polovina Cliffs.....	650	322	972
	Little Polovina.....	236	360	596
	Total.....	1,106	1,088	2,194
12.....	Morjovi.....	1,434	835	2,269
	Vostochni.....	739	403	1,142
	Total.....	2,173	1,238	3,411
13.....	Tolstoi.....	876	394	1,270
	Lukanin.....	204	147	351
	Kitovi.....	486	205	691
	Total.....	1,566	746	2,312
14.....	Zapadni.....	978	908	1,886
	Little Zapadni.....	551	182	733
	Zapadni Reef.....	221	195	416
	Total.....	1,750	1,285	3,035
St. Paul Island total.....		8,553	5,616	14,169
	St. George Island			
15.....	Zapadni.....	296	211	507
	South.....	288	57	345
	Total.....	584	268	852
16.....	East Reef.....	139	42	181
	East Cliffs.....	233	43	276
	Total.....	372	85	457
17.....	North.....	687	466	1,153
18.....	Staraya Artil.....	274	294	568
St. George Island total.....		1,917	1,113	3,030
Pribilof Islands total.....		10,470	6,729	17,199

Appendix table 11.--Counts of harem and idle bulls, by island, Pribilof Islands, Alaska, 1911-41 and 1943-65

Year	St. Paul Island		St. George Island		Both islands	
	Harem	Idle	Harem	Idle	Harem	Idle
1911	1,090	258	266	71	1,356	329
1912	1,077	93	281	20	1,358	113
1913	1,142	77	261	28	1,403	105
1914	1,316	159	243	13	1,559	172
1915	1,789	546	362	127	2,151	673
1916	2,948	2,278	552	354	3,500	2,632
1917	4,166	2,341	684	365	4,850	2,706
1918	4,610	2,245	734	199	5,344	2,444
1919	4,573	2,158	585	81	5,158	2,239
1920	3,542	1,078	524	83	4,066	1,161
1921	3,443	711	466	36	3,909	747
1922	3,184	493	378	15	3,562	508
1923	3,051	303	361	9	3,412	312
1924	3,127	375	389	15	3,516	390
1925	3,103	283	423	28	3,526	311
1926	3,478	368	556	55	4,034	423
1927	3,916	846	727	126	4,643	972
1928	5,059	1,208	991	241	6,050	1,449
1929	5,998	1,339	1,189	294	7,187	1,633
1930	6,823	1,555	1,489	344	8,312	1,899
1931	7,557	1,519	1,676	369	9,233	1,888
1932	8,268	1,940	1,820	409	10,088	2,349
1933	8,334	1,933	1,879	408	10,213	2,341
1934	8,841	1,860	1,929	422	10,770	2,282
1935	9,444	2,082	2,103	453	11,547	2,535
1936	10,055	2,253	---	---	---	---
1937	10,689	2,516	2,411	515	13,100	3,031
1938	10,720	1,787	---	---	---	---
1939	9,122	2,616	1,858	357	10,980	2,973
1940	9,662	3,968	1,988	571	11,650	4,539
1941	10,089	5,059	1,942	396	12,031	5,455
1943	10,948	3,523	2,107	330	13,055	3,853
1944	11,080	2,539	2,294	450	13,374	2,989
1945	10,750	4,055	2,434	750	13,184	4,805
1946	10,566	3,605	2,430	611	12,996	4,216
1947	10,160	3,331	1,808	479	11,968	3,810
1948	10,386	3,400	1,814	563	12,200	3,963
1949	9,554	2,976	1,746	552	11,300	3,528
1950	9,442	3,152	1,959	574	11,401	3,726
1951	9,434	3,581	1,825	549	11,259	4,130
1952	9,318	4,717	1,983	605	11,301	5,322
1953	9,848	5,912	2,285	826	12,133	6,738
1954	9,906	6,847	2,228	1,311	12,134	8,158
1955	9,034	8,650	2,130	1,902	11,164	10,552
1956	9,384	9,016	---	---	---	---
1957	9,562	10,060	2,423	2,693	11,985	12,753
1958	9,970	9,510	2,619	3,030	12,589	12,540
1959	10,003	11,485	2,527	2,699	12,530	14,184
1960	10,247	10,407	2,552	2,630	12,799	13,037
1961	11,163	11,791	2,843	2,489	14,006	14,280
1962	10,332	9,109	2,342	2,650	12,674	11,759
1963	9,212	7,650	2,071	1,890	11,283	9,540
1964	9,085	7,095	1,989	1,489	11,074	8,584
1965	8,553	5,616	1,917	1,113	10,470	6,729

Appendix table 12.--Age classification of female seals killed on St. Paul Island, 23-27 August 1965

Date	Rookery[1]	Number		Percent in each age class of sample							Estimated number killed from each age class						
		Females killed	Tooth sample	2	3	4	5	6	7	8+	2	3	4	5	6	7	8+
Aug.:																	
23.....	NEP.....	677	120	4	35	38	12	6	3	2	27	237	257	81	41	20	14
24.....	NEP.....	1,044	222	2	17	51	17	5	4	4	21	177	532	178	52	42	42
25.....	REEF.....	713	142	6	28	39	19	3	4	1	43	200	278	135	21	29	7
25.....	L. ZAP.....	92	24	----	34	34	13	8	8	3	----	31	31	12	8	8	2
26.....	L. ZAP-POL.	774	169	2	27	48	14	4	1	4	15	209	372	108	31	8	31
27.....	NEP.....	591	109	7	19	42	15	8	7	2	41	112	249	89	47	41	12
Season total.....		[2] 7,530	786								147	966	1,719	603	200	148	108

[1] NEP = Northeast Point (Vostochni and Morjovi rookeries); REEF = Reef, Gorbatch, Ardiguen; L. ZAP = Little Zapadni; POL = Polovina, Polovina Cliffs, Little Polovina.
[2] Includes 3,639 unclassified females taken during the male kill, 7 July to 9 August.

Appendix table 13.--Cumulative age classification of female seals killed on St. Paul Island, 23-27 August 1965

Date	Rookery[1]	Estimated number killed from each age class							Total kill	Percent killed from each age class						
		2	3	4	5	6	7	8+		2	3	4	5	6	7	8+
Aug.:																
23.....	NEP.....	27	237	257	81	41	20	14	677	4	35	38	12	6	3	2
24.....	NEP.....	48	414	789	259	93	62	56	1,721	3	24	46	15	5	4	3
25.....	REEF.....	91	614	1,067	394	114	91	63	2,434	4	25	44	16	5	4	2
25.....	L. ZAP.....	91	645	1,098	406	122	99	65	2,526	4	26	43	16	5	4	2
26.....	L. ZAP-POL.	106	854	1,470	514	153	107	96	3,300	3	26	45	15	5	3	3
27.....	NEP.....	147	966	1,719	603	200	148	108	[2] 3,891	4	25	44	15	5	4	3

[1] NEP = Northeast Point (Vostochni and Morjovi rookeries); REEF = Reef, Gorbatch, Ardiguen; L. ZAP = Little Zapadni; POL = Polovina, Polovina Cliffs, Little Polovina.
[2] Does not include 3,639 unclassified females taken during the male kill, 7 July to 9 August.

Appendix table 14.--Age classification of female seals killed on St. George Island, 16-27 August 1965

Date	Rookery[1]	Number		Percent in each age class of sample							Estimated number killed from each age class						
		Females killed	Tooth sample	2	3	4	5	6	7	8+	2	3	4	5	6	7	8+
Aug.:																	
16.....	ZAP.....	432	77	---	18	30	16	16	7	13	----	78	130	69	69	30	56
18.....	NOR.....	416	128	---	10	35	20	17	9	9	----	42	146	83	71	37	37
20.....	STAR.....	585	159	---	8	38	20	11	11	12	----	47	223	117	64	64	70
23.....	ZAP.....	458	88	1	29	33	14	10	3	10	4	133	151	64	46	14	46
25.....	STAR.....	397	107	---	7	22	16	17	8	30	----	28	87	64	67	32	119
27.....	ZAP.....	385	80	3	11	26	23	16	6	15	11	42	100	89	62	23	58
Season total.....		[2] 2,902	639								15	370	837	486	379	200	386

[1] ZAP = Zapadni; NOR = North; STAR = Staraya Artil.
[2] Includes 229 unclassified females taken during the male kill, 7 July to 6 August.

Appendix table 15.--Cumulative age classification of female seals killed on St. George Island, 16-27 August 1965

Date	Rookery[1]	Estimated number killed from each age class							Total kill	Percent killed from each age class						
		2	3	4	5	6	7	8+		2	3	4	5	6	7	8+
Aug.:																
16.....	ZAP.....	----	78	130	69	69	30	56	432	---	18	30	16	16	7	13
18.....	NOR.....	----	120	276	152	140	67	93	848	---	14	32	18	17	8	11
20.....	STAR.....	----	167	499	269	204	131	163	1,433	---	12	35	19	14	9	11
23.....	ZAP.....	4	300	650	333	250	145	209	1,891	---	16	34	18	13	8	11
25.....	STAR.....	4	328	737	397	317	177	328	2,288	---	14	32	18	14	8	14
27.....	ZAP.....	15	370	837	486	379	200	386	[2] 2,673	1	14	31	18	14	8	14

[1] ZAP = Zapadni; NOR = North; STAR = Staraya Artil.
[2] Does not include 229 unclassified females taken during the male kill, 7 July to 6 August.

Appendix table 16.--Soviet tags recovered from the kill, Pribilof Islands, Alaska, 1965

Date	Tag number	Age	Sex	Island of tagging	Rookery of recovery[1]
		Years	St. Paul Island		
July:					
27.....	H-16418.....	2	♂	Bering	NEP
30.....	H-23371[2].....	2	♂	Medny	REEF
Aug.:					
1.....	H-25371.....	2	♂	....do.....	NEP
6.....	H-29561.....	2	♂	....do.....	NEP
26.....	H-17418.....	2	♂	Bering	REEF
July:					
9.....	M-16303.....	3	♂	Medny	ZAP
16.....	M-16053.....	3	♂	....do.....	POL
17.....	M-13847.....	3	♂	....do.....	NEP
19.....	K-15296.....	3	♂	Bering	ZAP
20.....	K-16958.....	3	♂	....do.....	REEF
25.....	M-12506.....	3	♂	Medny	REEF
26.....	M-14282.....	3	♂	....do.....	POL
27.....	M-13844.....	3	♂	....do.....	NEP
Aug.:					
6.....	K-15342.....	3	♂	Bering	NEP
6.....	M-14869.....	3	♂	Medny	NEP
6.....	K-15546.....	3	♂	Bering	NEP
7.....	M-14918.....	3	♂	Medny	TOL
8.....	K-16521.....	3	♂	Bering	REEF
8.....	M-18241.....	3	♂	Medny	REEF
9.....	K-15504.....	3	♂	Bering	NEP
July:					
7.....	E-19658.....	4	♂	Medny	NEP
17.....	C-85770.....	5	♂	Medny	NEP
22.....	C-37130.....	5	♂	....do.....	NEP
27.....	E-2067.....	5	♂	....do.....	NEP
28.....	C-81430.....	5	♂	....do.....	NEP
29.....	C-52090.....	5	♂	....do.....	ZAP
Aug.:					
6.....	M-17450.....	3	♀	Medny	NEP
27.....	M-14122.....	3	♀	....do.....	NEP
9.....	B-2817.....	7	♀	Bering	NEP
			St. George Island		
July:					
12.....	M-16029.....	3	♂	Medny	NOR
21.....	K-16217.....	3	♂	Bering	EAST
28.....	M-21626.....	3	♂	Medny	NOR
Aug.:					
6.....	M-12131.....	3	♂	Medny	NOR
July:					
7.....	E-19801.....	4	♂	Medny	NOR
12.....	E-24421.....	4	♂	....do.....	NOR
12.....	E-24755.....	4	♂	....do.....	NOR

[1] NEP = Northeast Point (Vostochni and Morjovi rookeries); REEF = Reef, Gorbatch, Ardiguen; ZAP = Zapadni; POL = Polovina, Polovina Cliffs, Little Polovina; TOL = Tolstoi; NOR = North; EAST = East Reef, East Cliffs.

[2] Double-tagged--tag on right front flipper lost.

Appendix table 17.--Fur seal pups tagged and checkmarked, and marked only, St. Paul Island, 1965

Rookery	Proportion of total	Pups tagged and checkmarked			Pups marked only			
		Tag number	Tag and "V" notch left front flipper		Outside digit right hind flipper		"V" notch right front flipper	
	Percent		Date	Number[1]	Date	Number	Date	Number
Zapadni.....	11.4	R 1-1140	14 Aug.	1,140	18 Aug.	1,140	28 Aug.	1,140
Zapadni Reef.....	9.0	R 1141-2040	18 Aug.	920	18 Aug.	900	3 Sept.	927
Reef.....	22.9	R 2041-4330	18 & 20 Aug.	2,290	20 Aug.	2,290	28-29 Aug.	2,290
Polovina.....	10.2	R 4331-5350	17 Aug.	1,020	18 Aug.	1,020	1 Sept.	1,020
Little Polovina....	2.8	R 5351-5630	17 Aug.	280	17 Aug.	280	27 Aug.	280
Northeast Point[2]...	25.4	R 5631-8170	16-17 Aug.	2,540	17 Aug.	2,540	2 Sept.	2,540
Tolstoi.....	10.2	R 8171-9190	14 Aug.	1,020	14 Aug.	1,120	29 Aug.	1,020
Lukanin-Kitovi.....	8.1	R 9191-10000	15 Aug.	810	16 Aug.	810	27 Aug. 3 Sept.	810
Total.....	100.0			10,000		10,080		10,007

[1] All tags were used.
[2] Includes Vostochni and Morjovi rookeries.

Appendix table 18.--Record of fur seal pups tagged, Pribilof Islands, Alaska, 1941, 1945, 1947-49, and 1951-65

Year	Series	St. Paul Island	St. George Island	Location of tag	Checkmarks or marks
1941..	USA 1-10000;	10,000		Front flipper ♂♂ right front and hind flippers; ♀♀ left front and hind flippers	Branded, nape of neck
	USA 1-1000 and	1,000			Double tagged, branded nape of neck
	USA 5001-6000.....	1,000			
1945..	10001-11000.... (no letter prefix)	973		Left front flipper	None
1947..	A 1-20000.....	19,183		Left front flipper	1/4" hole between 1st (big toe) and 2nd digits left hind flipper
1948..	B 1-19673.....	19,532		Left front flipper	None
1949..	CS 1-20000.....	19,963		Left hind flipper	None
1951..	D 1-1000.....	1,000		Right hind flipper	1/2 left ear on 100 tagged pups removed
1952..	E 1-20000.....	19,979		Right front flipper	Tip of 1st digit (big toe) on right hind flipper sliced off
1953..	F 1-10000.....	9,990		Left front flipper	Tip of left front flipper sliced off
	G-7001-7400.....	398		....do.....	Do.
1954..	G-1-7000.....	7,000		Right front flipper	"V" notch near tip right front flipper
	G-7401-10400.....	3,000		....do.....	Do.
1955..	H 1-10000.....	49,870		Left front flipper	Tip of 1st digit (big toe) on left hind flipper sliced off
	10001-50000..... (no letter prefix)			....do.....	
1956..	I 1-10000.....		9,894	Right front flipper	Tip of right front flipper sliced off
	I 10001-50000.....	39,900		....do.....	Do.
1957..	J 1-10000.....		9,972	Left front flipper	"V" notch near tip left front flipper
	J 10001-50000.....	39,870		....do.....	Do.
1958..	K 1-10000.....		9,994	Right front flipper	"V" notch near tip right front flipper
	K 10001-50000.....	39,923		....do.....	Do.
	K 10001-15000.....	5,000		Right and left front flippers	Double tagged plus checkmark
1959..	L 1-10000.....		9,980	Left front flipper	Tip of left front flipper sliced off
	L 10001-50000.....	39,901		....do.....	Do.
1960..	M 1-12000.....		11,992	Right front flipper	Tip of right front flipper sliced off
	M 12001-60000.....	47,989		....do.....	Do.
1961..	N 1-10000.....		9,988	Left front flipper	"V" notch near tip left front flipper
	N-10001-50000.....	39,933		....do.....	Do.
1962..	O 1-10000.....		9,980	Right front flipper	"V" notch near tip right front flipper
	O 10001-50000.....	39,928		....do.....	Do.
1963..	P 1-5000.....		4,993	Left front flipper	Tip of left front flipper sliced off
	P 5001-25000.....	19,978		....do.....	Do.
1964..	Q 1-5000.....		4,993	Right front flipper	Tip of right front flipper sliced off
	Q 5001-25000.....	19,998		....do.....	Do.
1965..	R 1-10000.....	10,000		Left front flipper	"V" notch near tip left front flipper
	Marked only.....	10,007		Not tagged	"V" notch near tip right front flipper
	Marked only.....	10,080		....do.....	Tip of 1st digit (big toe) on right hand flipper sliced off

Appendix table 19.--Tags applied to seals selected as yearlings on the basis of body length, St. Paul Island, 1965

Rookery or hauling ground	Seals double-tagged	
	Tag series allotment	Tag on each front flipper
		Number
Zapadni rookery	1R 1-100	98
	1R301-325	25
Zapadni Reef and English Bay, sand beach hauling grounds	1R101-300	200
	1R326-400	73
	1R426-500	75
	1R699-700	2
	1R794-800	7
	1R932-1000	68
Lukanin and Kitovi rookeries and hauling grounds	1R401-425	25
Polovina, Polovina Cliffs, and Little Polovina rookeries and hauling grounds.	1R501-600	98
	1R856-931	76
Vostochni and Morjovi rookeries and hauling grounds	1R601-698	98
	1R701-793	92
	1R839-841	3
Reef and Gorbatch rookeries and hauling grounds	1R801-838	38
	1R842-855	13
Total	----------	991

Appendix table 20.--Counts of dead pups, by rookery, Pribilof Islands, Alaska, 1941 and 1948-65

Rookery	1941	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
St. Paul Island:																			
Morjovi	933		2,600	3,000	3,592		3,764	8,049	5,571	10,278	4,253	2,290	4,560	6,825	5,259	4,881	2,348	1,830	2,649
Vostochni	7,708	20,600	12,966	13,120	18,450		19,503	25,233	14,473	20,498	12,732	7,247	7,105	11,333	10,173	8,565	5,057	3,404	4,214
Little Polovina	292		1,600	1,740	2,208		2,211	3,852	2,782	4,443	1,695	975	1,597	2,427	2,415	2,121	923	631	1,132
Polovina Cliffs	2,356			3,800	5,580	2,954	5,451	6,413	5,964	8,637	4,425	1,826	2,586	3,462	4,576	2,957	2,160	1,097	2,856
Polovina			1,779	5,660	6,402	3,200	5,036	6,459	4,660	7,463	5,432	2,184	3,311	5,268	2,499	1,880	1,237	783	1,176
Ardiguen	42			170	242		189	282	387	364	249	102	141	331	411	225	141	102	459
Gorbatch	896			2,810	3,559		3,679	4,900	4,789	6,291	3,801	1,655	2,100	3,168	3,550	1,373	2,431	1,549	3,123
Reef	2,269			9,520	11,007		13,661	12,959	15,145	14,399	11,301	5,550	6,052	9,664	10,047	7,897	5,688	3,000	7,664
Kitovi	404		800	1,160	1,517		1,695	1,669	2,610	2,892	1,588	608	882	2,006	2,215	2,081	881	462	2,202
Lukanin			635	770	712		1,086	1,129	1,129	1,718	870	324	631	1,037	1,294	660	546	402	1,126
Tolstoi	1,623			4,230	6,033		6,154	7,552	6,489	6,789	5,659	2,823	3,691	5,237	4,761	3,004	3,274	2,614	3,955
Little Zapadni	372			2,120	2,804		2,446	4,979	3,555	4,611	2,325	1,312	1,691	4,148	3,047	2,399	2,580	1,101	2,461
Zapadni Reef	171		575	660	353		1,116	2,278	1,383	1,674	917	246	608	1,472	1,291	598	718	425	723
Zapadni	1,284			4,660	8,204		12,221	10,424	6,607	8,650	6,415	4,045	5,009	6,450	6,329	6,627	4,614	4,172	5,384
Counted total	18,350			53,420	70,663		78,212	96,178	75,544	98,707	61,662	31,187	39,964	62,828	57,867	45,268	32,598	21,572	39,124
Estimated oversight 5%	918			2,671	3,533		3,911	4,809	3,777	4,935	3,083	1,559	1,998	2,946	2,893	2,263	1,630	1,079	1,956
Total	19,268			56,091	74,196		82,123	100,987	79,321	103,642	64,745	32,746	41,962	65,774	60,760	47,531	34,228	22,651	41,080
St. George Island:																			
North							3,197	3,776		6,357	3,942	1,626	2,653	3,489	3,883	2,242	2,525	792	1,854
Zapadni and South							1,272	1,453		2,742	1,569	962	1,633	1,902	2,019	1,740	704	446	1,263
East Reef and East Cliffs							846	1,524		2,203	1,064	616	664	1,112	1,347	504	502	272	676
Staraya Artil							3,353	2,903		3,806	2,729	1,552	1,987	2,000	2,514	1,435	1,041	767	1,186
Counted total							8,668	9,656		15,108	9,304	4,756	6,937	8,503	9,763	5,921	4,772	2,277	4,979
Estimated oversight 5%							433	483		755	465	238	347	425	488	296	239	114	249
Total							9,101	10,139		15,863	9,769	4,994	7,284	8,928	10,251	6,217	5,011	2,391	5,228

Appendix table 21.--Mean weights[1] of seal pups about 1 September, year classes 1957-65, St. Paul Island

Group	1957[2]	1958[2]	1959[2]	1960[2]	1961[2]	1962[3]	1963[4]	1964[4]	1965[4]
	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.
Males:									
Tagged and checkmarked.	7.9 (262)	------	9.0 (182)	9.2 (211)	8.0 (186)	8.4 (300)	8.3 (299)	8.0 (297)	8.6 (297)
Untagged and unmarked..	8.7 (391)	11.4 (127)	9.4 (444)	9.8 (372)	8.5 (381)	9.2 (300)	8.9 (300)	9.1 (300)	9.5 (300)
Marked only.....	------	------	------	------	------	------	------	------	8.3 (300)
Females:									
Tagged and checkmarked.	7.4 (196)	------	8.0 (188)	8.4 (254)	7.2 (167)	7.6 (300)	7.3 (296)	6.8 (294)	7.4 (296)
Untagged and unmarked..	7.7 (351)	9.9 (121)	8.1 (386)	9.1 (363)	8.0 (466)	8.2 (300)	8.0 (300)	7.7 (300)	8.2 (300)
Marked only.....	------	------	------	------	------	------	------	------	7.2 (300)

[1] Numbers in parentheses are the number of pups in each sample.
[2] One week after tagging.
[3] Mean weights from the first of three weighings (1 week after tagging).
[4] Two weeks after tagging.

Appendix table 22.--Mean weights of seal pups about 1 September, by rookery, St. Paul Island, 1965

[Numbers in parentheses are the number of pups in each sample. The pups were weighed about 2 weeks after tagging or marking]

Rookery	Males			Females		
	Untagged and unmarked	Tagged and checkmarked	Marked only	Untagged and unmarked	Tagged and checkmarked	Marked only
	Kg.	Kg.	Kg.	Kg.	Kg.	Kg.
Vostochni and Morjovi....	9.81 (75)	8.86 (75)	9.16 (75)	8.33 (75)	7.61 (75)	7.88 (75)
Reef.....	9.29 (75)	7.90 (73)	8.46 (75)	8.09 (75)	6.99 (71)	7.31 (75)
Zapadni.....	9.76 (75)	9.17 (74)	7.67 (75)	8.65 (75)	7.84 (75)	6.84 (75)
Polovina.....	8.92 (75)	8.34 (75)	7.96 (75)	7.59 (75)	7.08 (75)	6.92 (75)
Mean.....	9.45	8.57	8.31	8.17	7.38	7.24

APPENDIX C

The 1965 field season on the Pribilof Islands extended from June to October. Dates of arrival and departure, and affiliations of research workers were:

Name	Arrival	Departure	Affiliation	Work
Ancel M. Johnson	14 June 21 Sept.	6 Aug. 6 Oct.	Bureau of Commercial Fisheries	Seal research, general
David Devin[1]	14 June	3 Sept.	Student, U. of Wash.	Do.
Daniel K. Odell[1]	---do.--	--do.-	Student, Cornell U.	Do.
Kenneth Johnston[1]	---do.--	--do.-	Student, Colorado U.	Do.
Patrick Kozloff[1]	---do.--	--do.-	Student, U. of Alaska	Do.
Victor B. Scheffer	---do.--	10 July	Bureau of Commercial Fisheries	Seal research, special projects
Alton Y. Roppel	8 July	14 Aug.	--------do.---------	Seal research, general
Terrance M. Wilson[1]	6 July	9 Sept.	Student, Cornell U.	Seal research, mortality
Mark C. Keyes	19 July	3 Sept.	Bureau of Commercial Fisheries	Do.
Ford Wilke	6 Aug.	31 Aug.	--------do.---------	Seal research, general
Raymond E. Anas	---do.--	3 Sept.	--------do.---------	Do.
David Galaktionoff[1]	17 June	24 Aug.	St. Paul Island resident	Do.
Benjamin Misiken[1]	17 June	20 Aug.	St. Paul Island resident	Seal research, general
Dionesy Bordukofsky[1]	---do.--	--do.-	--------do.---------	Do.
Agafon Krukoff, Jr.[1]	---do.--	3 Sept.	--------do.---------	Do.
Lavrenty Stepetin[1]	---do.-- 21 Sept.	--do.- 8 Oct.	--------do.---------	Do.
Innokenty C. Lestenkof[1]	6 July	31 Aug.	St. George Island resident	Do.
Innokenty Lestenkof Jr.[1]	---do.--	--do.-	--------do.---------	Do.
Max Thompson	20 June	18 Sept.	Smithsonian Institution	Bird marking
Robert L. DeLong	---do.--	--do.-	--------do.---------	Do.

[1] Temporary employee.

Two members of a four-man Task Force Committee scheduled to review research programs of the Marine Mammal Biological Laboratory 1-12 November 1965 were on St. Paul Island 6-14 August to gain information that later assisted them in their review. They were: Committee Chairman Gerald V. Howard, Director of the Bureau of Commercial Fisheries Tuna Resources Laboratory at La Jolla, Calif.; and Marvin D. Grosslein, biometrician from the Bureau's Biological Laboratory at Woods Hole. Mass.

Thomas C. Poulter, Director, Stanford Research Institute, and assistants Diane Slaughter and Richard Jennings were on St. Paul Island 9-29 July to make sonar recordings of fur seals for the Institute's Biological Sonar Laboratory.

Allison M. Craig and assistant Fred Tarasoff studied reproductive maturation in female fur seals on St. Paul Island 6 August to 15 September. Miss Craig represents the Fisheries Research Board of Canada, which supports her fur seal research at the University of British Columbia.

Joseph Daniels, embryologist from the University of Colorado, was on St. Paul Island 18-31 August to study in-vitro incubation of fur seal blastocysts. He was assisted by Michael Cowan.

Francis H. Fay of the U.S. Public Health Service was on the Pribilof Islands 17-26 August examining shrews, lemmings, and foxes for the hydatid tapeworm (Echinococcus).

Keith Farrell, Department of Agriculture, Washington State University Extension, was on St. Paul Island 17-18 August in connection with a study proposed for determining the susceptibility of fur seals to salmon poisoning and Elokomin fluke fever. These diseases are carried by the intermediate stages of the intestinal fluke Troglotrema salmincola that infects salmon. The fluke matures in carnivores.

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